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M. STEPHEN MAYOU

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DISEASES OF THE EYE

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Preface.

This book is written with the object of presenting to students who are beginning the subject and to practitioners a short, practical manual of diseases of the eye. If the book appear dogmatic, I would plead in extenuation that it is better for a beginner to have a knowledge of one method or theory than a confused smattering of several.

External diseases and such others as are most frequently met with in general practice are dealt with more fully than diseases of the fundus which do not so often come under the notice of those for whom this book is intended.

With a few exceptions, only well-established theories and methods of treatment have been put forward, but I have not hesitated to include a few more recently introduced methods of which I have had practical experience.

I am indebted to Messrs. M. L. Hepburn, F.R.C.S., and E. Playfair, M.D., for their help in preparing these pages for the press.

For some of the illustrations I have to thank Misses Stoddard and Kelley. The microphotographs are taken from my own histological specimens made in the laboratory of the Central London Ophthalmic Hospital. I have to thank Messrs. Weiss for the use of their blocks for the illustrations of instruments. The index was made by Miss E. Sewell.

M. S. MAYOU.

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CONTENTS

PAGE

CHAPTER I

METHODS OF EXAMINATION 1

CHAPTER II

ELEMENTARY OPTICS AND REFRACTION 27

CHAPTER III

DISEASES OF THE CONJUNCTIVA 65

CHAPTER IV

DISEASES OF THE CORNEA AND SCLEROTIC . . . 126

CHAPTER V

DISEASES OF THE IRIS, CILIARY BODY, AND CHOROID 156

CHAPTER VI

DISEASES OF THE LENS 193

CHAPTER VII

DISEASES OF THE RETINA, VITREOUS AND OPTIC NERVE 208

CHAPTER VIII

GLAUCOMA 258

CHAPTER IX

PAGE
DISORDERS OF THE EXTRA-OCULAR MUSCLES AND MOVEMENTS OF THE EYE 272

CHAPTER X

DISEASES OF THE EYELIDS AND LACHRYMAL APPARATUS 290

CHAPTER XI

DISEASES OF THE ORBIT 314

CHAPTER XII

OPERATIONS 322
APPENDIX 373
INDEX 381

LIST OF FIGURES

FIG. PAGE

1. Method of using focal illumination . . . 4
2. Diagram to show why the pupil appears black 6
3. Ophthalmoscope 7
4. Indirect method of examination by the ophthalmoscope 8
5. Showing the path of the rays (Indirect method) 9
6. Direct method of examination by the ophthalmoscope 11
7. Showing the path of the rays (Direct method) 12
8. Author's central scotometer 19
9. McHardy's Perimeter 21
10. The course of a ray passing through a prism 28
11. To show how a spherical lens is composed of two sets of prisms 28
12. Varieties of lenses 29
13. Emmetropia 32
14. Hypermetropia 33
15. Myopia 33
16. Showing the formation of a retinal image . 34
17. The appearance of the shadow in retinoscopy 38
18. The correction of hypermetropia with a convex lens 42
19. Myopic Crescent 47
20. Correction of myopia with a concave lens . 49
21. Snellen's test types 57
22. New gland formation in the conjunctiva . 69
23. New gland formation in the conjunctiva . 69
24. New gland formation in the conjunctiva . 69
25. Conjunctival follicles 71
26. Diplobacilli 75
27. Eye bath 77
28. Koch-Week's Bacillus 78
29. Gonococci in ophthalmia neonatorum . . 81
30. Trachoma with Pannus 95

FIG. PAGE
31. Papillary formation in early Trachoma . . 98
32. Trachomatous Pannus 99
33. Graddy's forceps 102
34. Spring Catarrh 107
35. Papilla in vernal catarrh 108
36. Eosinophile cells in vernal catarrh . . 109
37. Phlyctenule 113
38. Phlyctenule before rupture 115
39. Phlyctenule after rupture 116
40. Pterygium 118
41. Xerosis of the Conjunctiva 120
42. Polypus of the Conjunctiva 122
43. Showing types of new vessels in trachoma and interstitial keratitis 127
44. Pneumococci from serpiginous corneal ulcer . 133
45. Anterior Synechiae after perforating corneal ulcer 135
46. Anterior Staphyloma after corneal ulceration . 136
47. Anterior Staphyloma 137
48. Dendritic keratitis 138
49. Interstitial keratitis 142
50. Author's chair and headpiece for the localisation of foreign bodies in the eye by X Rays . . . 150
51. Persistent pupillary membrane . . . 166
52. Posterior synechiæ following iritis . . . 169
53. Keratitis punctata (K.P.) 171
54. Tubercle of the iris 172
55. Iris bombé in secondary glaucoma . . 174
56. Acute Iritis with Hypopyon 177
57. Syphilitic disseminated choroiditis . . . 185
58. Tubercle of the choroid (miliary) . . . 187
59. Tubercle of the choroid 188
60. Senile cataract—seen by focal illumination . 195
61. Senile cataract—seen with the ophthalmoscope 195
62. Position of lenticular opacities . . . 196
63. Congenital dislocation of the lens . . . 205
64. Opaque (medullated) nerve fibres . . . 210

FIG. PAGE

65. Arterio-sclerosis in a retinal vessel . . 213
66. Thrombosis in a retinal vein 217
67. Albuminuric Retinitis 220
68. Section through the macula lutea in albuminuric retinitis 221
69. Intra-retinal hæmorrhage—albuminuric retinitis 221
70. Subhyaloid hæmorrhage 222
71. Subhyaloid hæmorrhage 223
72. Glioma of the retina 230
73. The optic nerves and their connections . . 237
74. Bitemporal hemianopia in acromegaly . . 239
75. Homonymous hemianopia 240
76. Fuchs' coloboma of the optic nerve . . 242
77. Optic neuritis 244
78. Central scotoma in retro-bulbar neuritis . . 248
79. Tumour of the optic nerve (neuro-fibromatosis) 255
80. Neuro-fibromatosis—section of the tumour . 256
81. The normal angle of the anterior chamber . 259
82. Angle of the anterior chamber in glaucoma . 260
83. Angle of the chamber in long standing glaucoma 261
84. Glaucoma. Cupping of the disc. . . . 263
85. The field in chronic glaucoma . . . 264
86. Maddox Rod 278
87. Position of false images in paralysis of the superior and inferior oblique 285
88. Position of false images in paralysis of the recti muscles 285
89. Tarsal (Meibomian) Cyst 298
90. Canaliculus dilator 307
91. Lachrymal syringe 311
92. Lachrymal Abscess 312
93. Undine for irrigating the conjunctival sac . 324
94. An eye bandage 326
95. A pressure bandage 326
96. Eye speculum 329
97. Fixation forceps 330
98. Graefe knife 331

FIG. PAGE
99. Capsule forceps 332
100. Vectis 333
101. Incision and iridectomy for cataract . . 334
102. Discission needle 336
103. Keratome 337
104. Iris forceps 340
105. Iris scissors 340
106. Incision and iridectomy for glaucoma . . 341
107. Incision and iridectomy for optical purposes 343
108. Enucleation scissors 345
109. Strabismus hook 349
110. Advancement forceps 351
111. Panas' operation for ptosis 355
112. Epilation forceps 357
113. Arlt's operation for trichiasis . . . 357
114. Lid clamp 358
115. Canaliculus knife 359
116. Snellen's sutures 360
117. Muller's retractor 366
118. Axenfeld's retractor 366
119. Eyelid retractor 368

LIST OF PLATES

PLATE
I Fig. 1. Normal Fundus . . } To face p. 15
Fig. 2. Tessellated Fundus . }
II Anatomy of the Anterior Segment of the Eye . . . . . . ,, 157
III Fig. 1. Disseminated Choroiditis } ,, 186
Fig. 2. Optic neuritis . . }
IV Fig. 1. Albuminuric Retinitis . } ,, 221
Fig. 2. Retinitis Pigmentosa . }
V Fig. 1. Retinal detachment .
Fig. 2. Glaucoma—cupping of the Disc . . . . . . ,, 263

CHAPTER I

METHODS OF EXAMINATION

The diseases which affect the eye are frequently of such a nature that their salient features are very liable to be overlooked unless the greatest care is exercised. It is, therefore, important that a routine examination should be undertaken in every case. Especially is this of importance to the beginner, for, although no organ in the body lends itself to more accurate observation and treatment, the technique is correspondingly more difficult. Mistakes made on these points are so obvious to the patient that they probably bring more discredit to the practitioner than is the case with disease of any organ which a medical man is called upon to treat.

The methods of examination are twofold; namely, subjective and objective; and they should be carried out in the following order :—

I. External examination.
II. Tension.
III. Vision and Light sense.
IV. The ophthalmoscopic examination.
V. Visual fields.
VI. Colour sense.
VII. General examination of the patient.

I. **External Examination.**

(*a*) The general aspect of the patient—the appearance of the face, brows and orbits should be noted.

(*b*) The lids—their position, movements and margins ; the tarsus, the lachrymal sac and gland.

(*c*) The globes—their position, direction, size, movements and projection forward, or recession.

(*d*) The conjunctiva, both bulbar and palpebral, plica semilunaris and caruncle should be examined.

(*e*) The cornea—its transparency, its size, surface and sensation.

(*f*) The sclerotic—thinning or thickening.

(*g*) The anterior chamber—depth and contents.

(*h*) The iris—colour, pattern, and plane of the surface.

(*i*) The pupil—size, irregularities, its reaction to light, both direct and consensual, also to convergence.

(*j*) The lens—for opacities.

After inspection in a good diffused daylight the patient should be taken into the dark room, and the finer details of the above examined by focal illumination.

Method of Examination by Focal Illumination (see Fig. 1).—The lamp is placed at some distance in front and slightly to one side of the patient; the light is collected by means of a large lens (about + 10 D) and brought to a focus on the part to be examined. Fine details, such as keratitis punctata, should be looked for by means of a corneal lens having a magnification of from about six to nine times.

II. **Tension.**—**Method of taking Tension.**—The patient is made to look down, and the little and ring fingers of the observer's hands are fixed upon the face and forehead. The eye is steadied by the finger of one hand, and the tension taken by pressing gently on the globe through the lid with the finger of the other. It is desirable that the same finger should take the tension of both eyes.

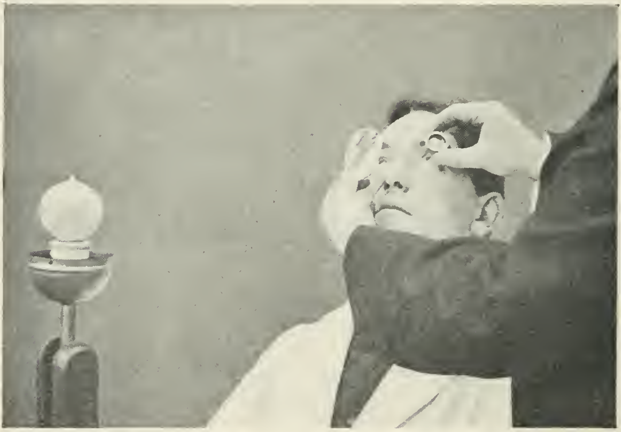


FIG. 1.—Method of using focal illumination. The rays from the lamp are concentrated on the eye by means of the lens, the parts are then magnified (if necessary) by means of the corneal lens.

The degrees of tension in an eye are expressed thus :—

T+1 when the eye is harder than normal, but can be dimpled by the finger.

T+2 when the eye can hardly be dimpled.

T+3 extreme or stony hardness.

In a similar way—

T − 1 is an eye which is slightly soft,

T − 2 a soft eye which still has some tension,

T − 3 a flaccid eye in which no tension is present.

The *normal intra-ocular* tension varies; in cases of doubt the expression T + ? T − ? are used.

III. **The Vision** for distance and the near vision should be taken, and any error of refraction corrected. The light sense is examined by test types specially devised for the purpose.

IV. **The ophthalmoscopic examination.**—Previous to the invention of the ophthalmoscope by Helmholtz, the rays of light passing into the eye were supposed to be absorbed by the choroid. It is now known that the majority of rays are reflected back from the fundus through the pupil and come to a focus on the source of light, hence the pupil under ordinary circumstances looks black (see Fig. 2). Where, however, as in animals and in some cases in human beings with a large refractive error, the reflected light is not brought back to a focus on its point of origin, the pupil may appear illuminated. To overcome the difficulty of placing the observing eye exactly at the source of light, a concave mirror, which concentrates the rays, is used instead of a candle (as a source of light) with a central hole through which the rays of light can pass to the observer's eye. In the modern ophthalmoscope (of which Cooper's and Morton's are the forms most commonly used), there are two mirrors—the large one is called the indirect mirror, and the small one, with a shorter radius of curvature, is called the direct mirror. Behind the apertures a series of lenses can be brought into place to correct the errors of refraction on the part of the patient and the surgeon, and for the magnification and examination of opacities in the media, etc. The methods of examination are, (1) indirect, and (2)

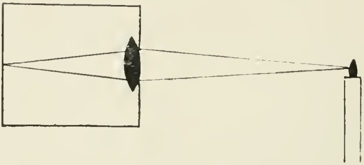


Fig. 2.—Diagram to show why the pupil appears black. The reflected rays from the fundus come back to a focus on the point at which they originated.

direct. Both methods have their advantages, and should be used in every case.

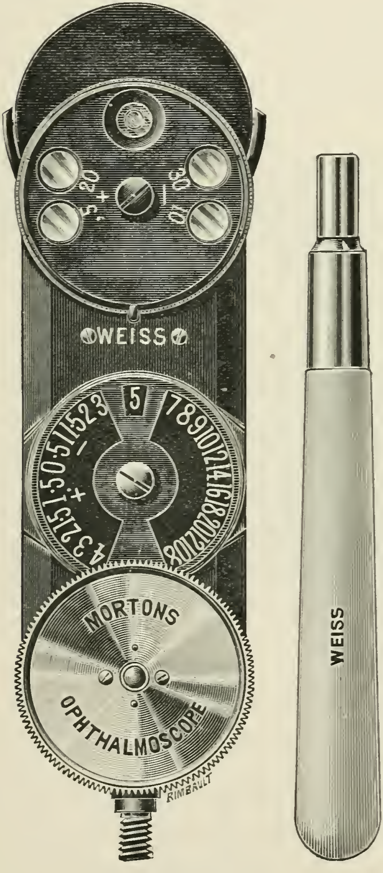


FIG. 3.

Indirect Method (Figs. 4 and 5).—The advantages are that—

(*a*) A larger field is obtained than by the direct method, and hence it is useful for securing a general view of the fundus.

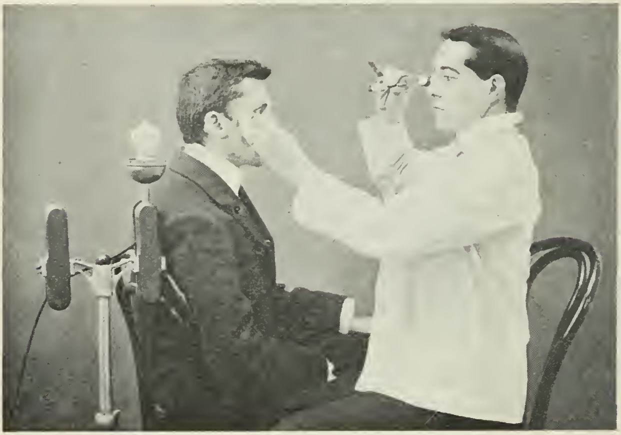


Fig. 4.—The indirect method. The lamp should be placed on the same side of the patient as the hand holding the ophthalmoscope.

(*b*) In cases of high myopia this is especially useful, as the direct method gives a comparatively small field, although it is more highly magnified.

(*c*) More light is reflected from the eye under examination into that of the observer, and hence it is possible to see the fundus in cases of opacities of the media.

The patient is seated in a chair, with a lamp slightly behind and to the left side of the head. The surgeon stands or sits about a metre away, and with the large ophthalmoscopic mirror before his right eye he reflects the light of the lamp into the patient's eye. The pupil is then seen to be illuminated (red reflex). The surgeon's hand holding the lens is steadied on the forehead of the patient by means of his little finger. The lens is then placed before the eye to be examined, and gradually drawn away from the patient towards the surgeon until the fundus is brought into focus. The patient is then directed to look a little to his left if the right eye is being examined,

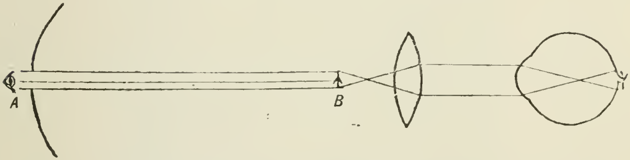


FIG. 5.—Indirect method showing the path of the rays.
A. Observing eye.
B. Position of the virtual inverted image.

so as to bring the optic disc into view. This is easily done by asking the patient to look at the little finger of the surgeon's right hand which is holding the ophthalmoscope. In the case of the left eye the gaze should be directed a little to the patient's right, as, for instance, at the surgeon's left ear. A lens of +2 D in front of the sight hole renders the image more distinct. Having examined the disc, the macula should be brought into view by making the patient look straight at the hole in the ophthalmoscopic mirror. Finally, all parts of the fundus should be examined by making the patient look up, down, in and out. When the patient is looking at an object other portions of the fundus can be brought into view by moving the lens in the surgeon's hand. In cases of depressions and elevations in the fundus, such as cupping of the disc, if the lens in front of the eye be moved in this way it will be found on observing the image that the bottom of the depression or summit of the elevation appears to move at a different rate from the surrounding fundus. This appearance is known as "parallax," and is useful when diagnosing an elevation or depression by this method of examination.

The magnification of the fundus is about five times the natural size in the emmetrope.

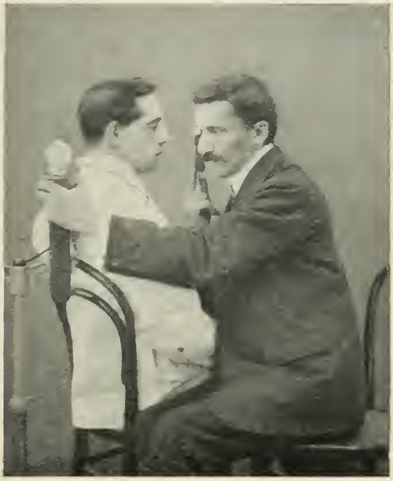


FIG. 6.—The direct method. When the red reflex is obtained, the observing eye is brought as close as possible to the patient.

The image of the fundus formed in the indirect method is an inverted virtual one, and is situated in front of the lens which is in the observer's hand. The diagram (Fig. 5) shows the course of the reflected rays which produce the image.

Direct Method (Figs. 6 and 7).—The advantages are—

(*a*) It gives a high magnification—fifteen times the natural size in the emmetrope—and hence it is the ideal method for detailed examination.

(*b*) Elevations and depressions can be accurately measured.

(*c*) Opacities in the media and their situation can be correctly gauged and examined.

(*d*) The refraction can be roughly estimated.

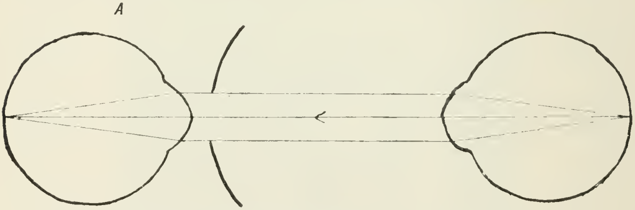


FIG. 7.—Direct method showing the path of the rays.
A. Observer's eye.

The light is placed on the same side of the head as the eye to be examined, the surgeon sitting or standing also on the same side. The small mirror of the ophthalmoscope is then so arranged that its inclination is directed towards the light. By reflecting the light into the eye from the mirror, the red reflex is now obtained, the observer's eye being situated directly behind the aperture. The eye of the surgeon is then approximated as nearly as possible to the eye of the patient, and relaxation of the accommodation is assured by keeping both eyes open and gazing as if into the distance. If the fundus is not clearly seen lenses are brought up behind the ophthalmoscope, in order to correct any existing errors of refraction on the part of the surgeon or patient, until the fundus becomes visible. The disc is then located by making the patient look straight in front of him, the observer's eye being placed a little to the outer side of the eye under examination. The macula is next observed either by transferring the surgeon's eye to a point immediately in front of the patient's, or by directing the patient to look into the hole of the ophthalmoscope. The other portions of the fundus are then examined by directing the patient to move the eye in different directions.

Refraction can be estimated by this method, but the accommodation must be perfectly relaxed on the part of both the surgeon and the patient, the latter being preferably under a mydriatic. The disc is brought into view and the lenses are rotated behind the ophthalmoscope until the highest convex glass or the lowest concave glass is found with which it is seen distinctly. This is the measure of refraction on the part of the patient and surgeon. The surgeon's refraction must, therefore, be deducted from the patient's. The method is of little real value, and is not so satisfactory as retinoscopy, but it is useful to practise it for the following reasons :—

Depressions and Elevations are measured by focussing a vessel on the top of an elevation or at the bottom of a depression by means of a lens behind the ophthalmoscope, and then comparing the strength of the lens required with that necessary to see a vessel in the surrounding fundus. A depression will take a higher glass to the concave side, whilst an elevation will take a higher glass to the convex side, 3 dioptres being equal to about 1 mm. in the emmetrope.

The Size of foci of disease, etc., in the fundus is judged by comparison with the optic disc, which is about 2 mm. in diameter.

Examination of Opacities in the Media.—By placing

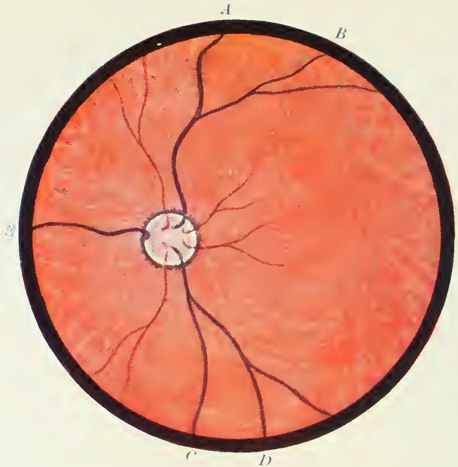


FIG. 1.—NORMAL FUNDUS.

A. Superior nasal vein. *B*. Superior temporal vein. *C*. Inferior nasal vein. *D*. Inferior temporal vein. *E*. Cilio-retinal vein. The arteries are known by the same terms. The two small vessels to the outer side of the disc are macular arteries.

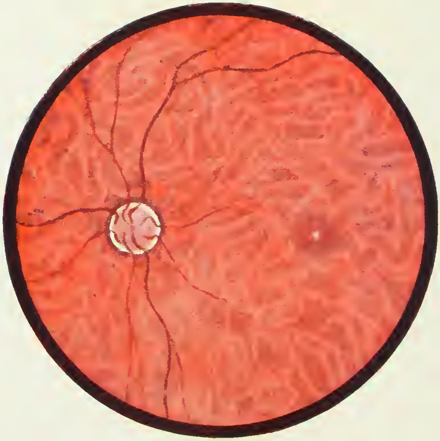


FIG. 2.—NORMAL FUNDUS OF A DARK SUBJECT (TESSELLATED FUNDUS).

The choroidal vessels are seen between the deeply pigmented areas. The macular region is of a more uniform colour than the surrounding fundus, the white spot (fovea centralis) is due to a reflex of light from its surface. Note the scleral (white) and choroidal ring (black) around the disc.

To face page 15.] [*Plate I*.

convex lenses behind the ophthalmoscope all details in the media from immediately in front of the retina up to the surface of the cornea may be examined. The nearer the opacity is to the surface of the cornea, the higher will be the + lens required for its examination. Thus, for example, opacities in the lens require about +20D.

The Normal Fundus (Plate I).—1. **The Background.**—(*a*) *The red reflex* of the fundus is due to the blood in the choroid, since the retina in health is translucent.

(*b*) *The colour* varies in dark or fair people, depending on the amount of retinal and choroidal pigment present. Thus in a negro the fundus looks almost black. In dark people (Plate I) it has a tesselated appearance, the choroidal vessels being seen as light areas, whilst in fair subjects a uniform red appearance is obtained. In albinos, in whom the pigment is absent, the white sclerotic is seen covered by the choroidal vessels.

(*c*) *Reflex of light* from the surface of the retina and retinal vessels is not infrequently seen, especially observed in children and hypermetropes.

2. **The Optic Disc** is slightly to the inner side.—(*a*) *The colour* is pink, but may vary considerably in health.

(*b*) *The choroidal ring*, or edge of the choroid, is seen around the disc as a blackish band, and outside this again *the scleral ring* appears as a white band.

(*c*) *The lamina cribrosa* is seen as faint greyish markings in the central portion of the disc—seen best a little to the temporal side of the entrance of the main vessels.

(*d*) *A Physiological cup* may be present due to the formation of a funnel-shaped arrangement of the optic nerve fibres as they pass into the optic nerve.

(*e*) *The disc margins*, as a rule, are sharply defined, but in some cases of hypermetropia they may be blurred, and at the same time the disc is often pinkish in colour, rendering the condition liable to be mistaken for optic neuritis. It can usually be distinguished by the absence of swelling.

3. **The Vessels.**—(*a*) *The central artery and vein.*—The veins are distinguished from the arteries by being larger and darker in colour. The vessels divide into superior and inferior immediately on

their entrance into the globe from the nerve. The superior and inferior vessels again divide into a temporal and a nasal branch. Either from the primary artery or from their branches fine vessels are seen running outwards from the disc towards the macular region; these are known as the *macular vessels*. Occasionally one or more of the vessels may be derived from the ciliary circulation, and are then seen curling round the margin of the disc; these are known as *cilio-retinal vessels* (Plate I).

The retinal vessels do not penetrate more deeply into the retina than the internal nuclear layer, the outermost layers of the retina depending for their nutrition mainly on the choroid. The retinal arteries are terminal vessels, so that if one is blocked, the collateral circulation is insufficient to carry on the nutrition of that part of the retina supplied by it, and its function is lost.

(*b*) *Arterial reflex*, or silver wire arteries, appear as white lines along the vessels. They may be :—

- (i) Physiological, as in hypermetropia.
- (ii) As the result of exudation into the perivascular sheath (Plate IV).

(iii) Thickening of the arterial coats (Fig. 65).

4. **The macula lutea** is situated about 3 mm. outwards from the disc, and is distinguished by—

(*a*) Being free from vessels.

(*b*) Being darker in colour owing to increased amount of pigment in the choroid behind it.

(*c*) A reflex of light which is often seen around the centre (*fovea centralis*), sometimes as a ring, sometimes as a bright point (Plate I).

5. **The Peripheral Parts** of the retina should now be examined. The normal mottling of the pigmentation varies considerably in health, and hence it is often difficult to distinguish pathological from physiological pigmentation. Physiological mottling of the pigment in children is not at all uncommon.

V. **The Field of Vision** is divided into (1) central vision, (2) peripheral vision.

1. **Central Vision** is the perception of objects in a direct line with the visual axis ; that is to say, the image which falls on the macula lutea. It is tested by—

(*a*) Visual acuity, which is always low in cases where any defect is present.

(*b*) A small white or coloured piece of paper on the end of a pen; or better still, by means of a scotometer. The scotometer which I have had made for me consists of an iris diaphragm behind which white and coloured discs are placed (Fig 8).

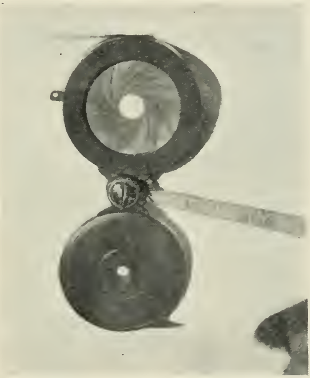


FIG. 8.—Author's central scotometer for measuring the size of small central scotomata. The aperture in the iris diaphram is enlarged till the colour is appreciated, the size of the aperture is recorded on the side of the instrument. The handle of the instrument is a retinoscopy mirror.

In making the test one eye should always be covered, and the patient made to gaze at the point of intersection in the iris diaphragm of the scotometer, and the opening is then enlarged until the white or coloured paper behind the aperture is seen, the size of the scotoma being the size of the aperture of the iris diaphragm. The distance of the scotometer from the patient is measured by means of a tape attached to the instrument. Large scotomata are easily mapped out on the perimeter.

2. **Peripheral Vision** is the sense of surrounding objects, although the observer is not looking directly at them. It is tested—

(*a*) By means of a perimeter,

(*b*) Against the observer's fields.

(*a*) *The perimeter.*—The one now most commonly in use is McHardy's (Fig. 9). It consists of an arc corresponding to the curve of the retina and moving round a central point, which is marked with a white spot, known as the fixation point. Upon the arc a white or coloured disc can be made to move by means of a screw turned by hand. A needle moves synchronously with the white disc on the arc, so that the chart can be punctured automatically and the fields accurately mapped out. The patient is seated with his back to a good light, and placing his chin on the rest, is made to gaze continually at the fixed white

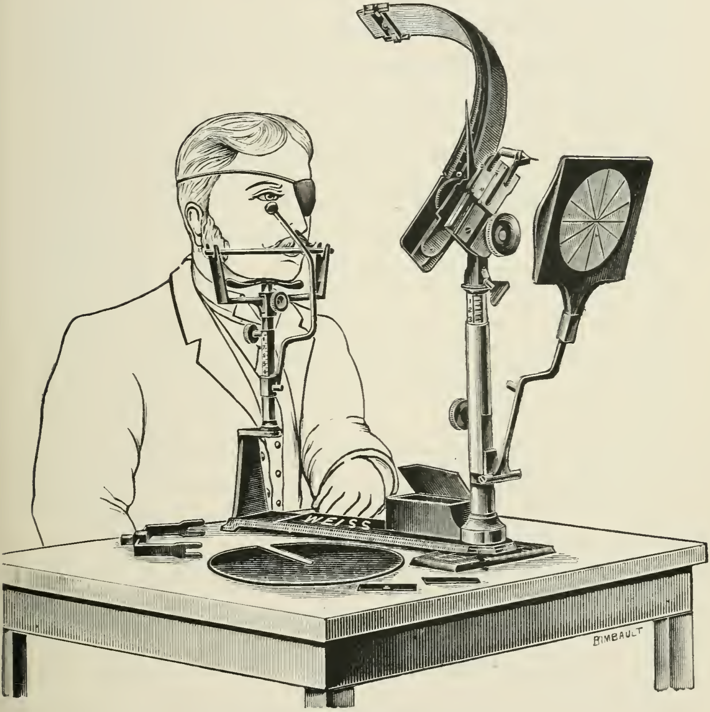


FIG. 9.—McHardy's Perimeter.

point, which should have been previously adjusted to the level of the eye. The other eye is carefully covered with a shade. The movable disc is drawn inwards over the fixation point, and the needle made to correspond to the central point on the chart. Whilst the patient looks steadily at the fixation point the disc is moved outwards till it disappears from view, and in this way any defect or scotoma in the field is detected. It is then wound in until it again comes into view, and the position on the chart is then recorded by bringing the latter into contact with the needle. The whole field in its various meridians is mapped out in the same way, and the points joined up by a line.

Peripheral fields are defective in two ways—(1) Scotomata (islands of defect), (2) peripheral contraction.

Scotomata may be "*relative*"; when the blindness over the area is not complete; "*absolute,*" when the blindness in complete. There is normally one absolute scotoma in every field corresponding to the optic disc, which is known as the blind spot. It is situated to the outer side of the fixation point. It is not apparent under ordinary circumstances, since in patients with binocular vision the two fields overlap each other, so that the defects due to the blind spots are covered. When the patient is aware of the defect, scotomata are called "*positive*"; when unaware of it, they are called "*negative*."

Peripheral contraction of the field may take the form of a general contraction, as in some forms of optic atrophy, or a sector may be deficient, as in glaucoma. Normally the fields may be slightly deficient in patients with overhanging brows and large noses.

(*b*) *Against the observer's fields.*—This is a comparatively rough method. The patient closes one eye, e.g. the right, and is then directed to gaze at the right pupil of the observer, who in his turn looks into the left pupil of the patient, with his own left eye covered. Hand movements are then made in various parts of the field at equal distances from the patient and the observer, who compares his own field with that of the patient.

VI. Colour Vision.

Colour Blindness may be congenital or acquired.

Congenital Colour Blindness (Daltonism) may be total ; that is to say, all objects look grey like an engraving to the observer ; or partial, when one group of colours is confused, e.g. red-green blindness in which green cannot be distinguished from red. For the theories which are advanced to explain the condition students are referred to text books on physiology. **Acquired Colour Blindness** may be present in optic atrophy, retrobulbar neuritis, toxic amblyopia, etc., and will be treated of under these diseases.

To test patients' Colour Vision.—The tests usually employed are :—

1. *Holmgren's wools.* A test green skein is given to the patient and he is asked to pick out all wools of the same colour. Having done so he is asked for the name of the colour. If he does this correctly a red and then a blue skein are given to him to match in a similar way.

2. *The lantern test* is the most important for naval and railway men. Coloured lights are shown which they are required to name.

3. *The spectroscopic test* is indispensable for the scientific examination of colour vision.

Great care must be observed in carrying out these tests, as patients can often pick out the colours by their shading, capacity for recognition of which is very highly developed in the colour blind.

VII. **General Examination of the Patient.**—Too much stress cannot be laid on the general examination of the patient, since many diseases of the eye are only part of, and may be early manifestations of, some constitutional disease which, without careful examination, is liable to be overlooked.

The Urine should always be examined in cases of cataract, as not infrequently this may be of diabetic origin. Diseases of the vessels of the fundus are not infrequently associated with albuminuria.

The Nervous System should always be examined in cases of ocular paralyses, which are often the earliest manifestations of grave disease, such as locomotor ataxy, disseminated sclerosis, or general paralysis of the insane. Optic neuritis may be associated with severe cerebral lesions, such as tumours, meningitis, etc.; optic atrophy with both cerebral and spinal lesions.

Heart Disease may be manifest in the eye by pulsation of the retinal arteries or embolism.

Metastatic Diseases, such as new growths, tubercle, and pyæmia, may show their first manifestation in the eye.

Thyroid Disease.—Patients with exophthalmic goitre and myxœdema may present themselves on account of ocular trouble.

CHAPTER II

ELEMENTARY OPTICS AND REFRACTION

Definitions.—

Rays are emanations of light from a luminous object. They radiate from all sides of it in straight lines, and become, for practical purposes, parallel after about 6 metres.

Refraction, or bending of rays, takes place when they pass through media of different density. Thus a stick half in and half out of water appears bent. If rays pass through a piece of glass they are deflected, both at their entrance and exit. Thus rays passing through a prism are diverted towards its base (Fig. 10).

Reflection is the return of light from a surface.

A **pencil** of rays is a number of rays diverging from, or converging to, a point.

The **focus** is the point of intersection of these rays.

Lenses.—A lens may be (1) spherical, (2) cylindrical.

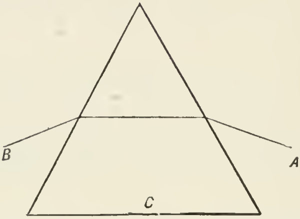


FIG. 10.—The course of a ray, *A*, *B*, passing through a prism it is refracted at its entrance and exit towards the base, *C*

1. *A spherical lens,* when broken up into its components, consists of two sets of prisms arranged (*a*) base to base, convex lens (sign +) (Fig. 11),

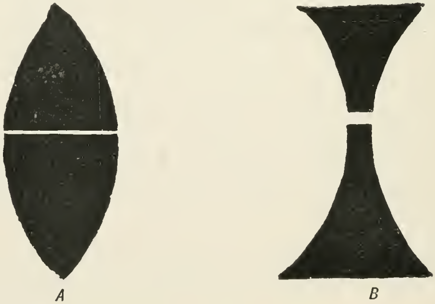


FIG. 11.—Showing how a spherical lens is composed of two sets of prisms.

A. Convex—prisms base to base.
B. Concave—prism apex to apex.

or (*b*) apex to apex, concave lens (sign $-$). The different varieties of lenses are shown below (Fig. 12).

2. *Cylindrical lenses* are segments of a cylinder and may be concave or convex. They only refract in one plane, i.e., at right angles to their axis.

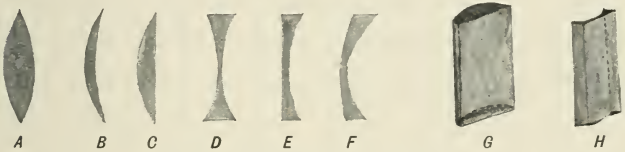


FIG. 12.—Varieties of Lenses.

A. Biconvex.
B. Concavo-convex.
C. Plano-convex.
D. Biconcave.
E. Plano-concave.
F. Convexo-concave.
G. Convex cylinder.
H. Concave cylinder.

The Numbering of Lenses.—Lenses are measured by their focal length. The standard is a lens which has a focal length of 1 metre, known as a dioptre (symbol D). Thus a lens having a focal length of 1 metre is 1 D; a lens having a focal length of 50 cm. is 2 D. It is, therefore, possible to calculate the dioptric equivalent of any lens from its focal length. Thus a lens having a focal length

$$\text{of } 10 \text{ cm. is } \frac{100 \text{ c.m.}}{10 \text{ c.m.}} = 10 \text{ D.}$$

The Principal Axis of a lens is the line joining the centres of curvature of both surfaces.

The Primary Ray is a ray passing through the principal axis, and is not refracted.

The Optical Centre is a point on the principal axis.

The Focal Length of a lens is the point at which *parallel rays* (i.e. rays coming from over 6 metres) are brought to a focus (primary). Thus the greater the curve the shorter the focal distance and the more powerful the lens. If the rays emanate from a point nearer than 6 metres they are brought to a focus at a different point (secondary).

An Image is a collection of foci corresponding to a luminous object—*Real* when formed by the natural intersection of rays; the rays must, therefore, have passed through a + lens and the object must be at a greater distance than the principal focus, the image formed being inverted. A *Virtual* image is formed by the prolongation backwards of rays to their focal point in front of the lens (i.e. between the lens and the object). All images produced by concave lenses are virtual, and are smaller than the object. A large upright virtual image is produced by a convex lens if the object is held nearer than the focal length of the lens.

Mirrors and Reflection.—If a ray of light strikes a plane mirror (angle of incidence) it is reflected from the mirror at the same angle in the opposite direction (angle of reflection). Therefore the angle of incidence = the angle of reflection. The angles of incidence and reflection lie on the same plane and on opposite sides of the perpendicular to the mirror.

Images produced by Mirrors.—A *real* image is produced on the same side of the mirror as the object, and a *virtual* one by tracing back the reflected rays to a focus on the opposite side of the mirror.

A Plane Mirror produces a virtual upright image the same distance behind as the object is in front.

A Concave Mirror.—*Parallel rays* striking a concave mirror are reflected and brought to a focus. If the object is beyond the focus it is small and inverted ; if nearer than the focus large and erect.

Refraction.—The eye roughly resembles a camera, the ground-glass screen or plate, on which the image is thrown, corresponding to the retina ;

the refractive media, i.e., the cornea, aqueous, lens and vitreous, corresponding to the photographic lens. The eye is unlike the camera in one respect, viz: that in order to bring near objects to a focus the shape of the lens is altered (accommodation) instead of the length of the camera. The eye, therefore, has a "static refraction" whilst at rest and a "dynamic refraction" when accommodating.

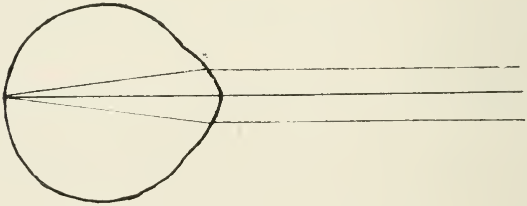


Fig. 13.—Emmetropia. The rays are brought to a focus on the retina.

In estimating the static refraction the power of accommodation is removed by the use of a mydriatic (homatropine, atropine), and it is an eye in this condition of which we speak when applying the following terms:—

Emmetropia is the condition in which parallel rays of light (objects over 6 metres away) are brought to a focus on the retina (Fig. 13).

Hypermetropia is the condition in which parallel rays of light (objects over 6 metres away) are not brought to a focus on the retina, but tend to converge to a point behind it (Fig. 14.).

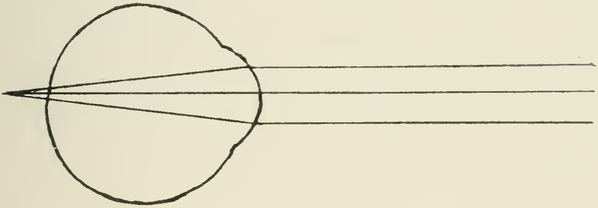


FIG. 14.—Hypermetropia. The rays if prolonged would come to a focus behind the retina.

Myopia (short-sight) is the condition in which the parallel rays of light (from over 6 metres) are brought to a focus before they fall on the retina (Fig. 15).

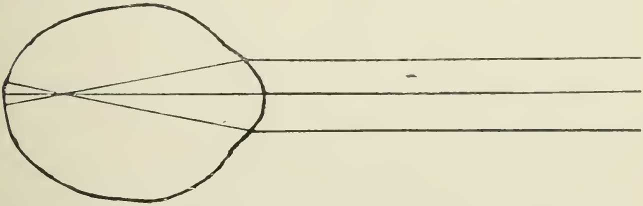


FIG. 15. Myopia. The rays come to a focus before falling on the retina.

Astigmatism is an inequality of the refractive media, so that the rays are not brought to a common focus on the retina.

The Retinal Image is formed on the retina by the convex lens of the media and is inverted, readjustment taking place in the brain. The principal axis of the media which represent a lens is called the optical axis. The optical centre is called the nodal point. The nodal point in emmetropia is situated about 15 mm. in front of the retina, that is to say in the posterior part of the lens itself.

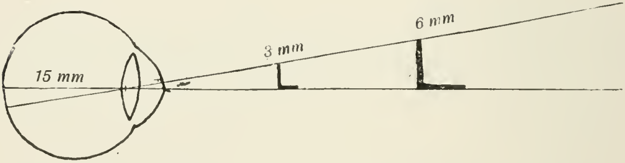


FIG. 16.—Diagram showing the formation of a retinal image.

The size of the image formed on the retina depends on its distance from the eye (Fig. 16).

Knowing the size of an object and the position of the nodal point, we have a means of calculating the size of the retinal image. In the same way the size of a scotoma in the field can be measured thus :—

$$\frac{\text{Diameter of the scotoma on the chart} \times 15 \text{ mm., i.e. the distance of the retina from the nodal point}}{\text{the distance of the eye from the perimeter}}$$

will give the actual size of the retinal scotoma.

If the patient is hypermetropic or myopic 1 mm. should be added to, or taken off, respectively, the length of the retinal image for every three dioptres of error.

Retinal images must be of a certain size before they can be appreciated as separate objects. Thus they must subtend an angle of 5°, i.e. about the distance between two cones in the macular region. On this principle the test types of Snellen are based (Fig. 16).

Accommodation is the increase in curvature of the lens necessary to adapt the eye for distinct vision at varying distances. It is brought about by the contraction of the ciliary muscle either (according to Helmholtz) by the relaxation of the tension on the capsule of the lens allowing it to assume its more rounded shape, or (according to Tscherning) by increase of tension on the fibres of the suspensory ligament squeezing the lens into a greater convexity on its anterior surface.

Loss of power of accommodation takes place regularly throughout life, and practically ceases to exist after the age of sixty, owing to the gradually increasing sclerosis of the lens. About the age of forty-five in the emmetropic, the near point, i.e. the point at which patients can see clearly, recedes to about 33 cm., which is just beyond the reading distance. This condition is known as "*presbyopia*", and is corrected by + glasses worn only for reading.

The near point is called the *punctum proximum* and is designated by the symbol "P." The far point, or *punctum remotum*, of an eye is infinity and is designated by the symbol "R." The range of accommodation is designated by the symbol "A." The range of accommodation in an eye is therefore calculated in the following way—

Emmetropia.—E.g.

$A = P - R.$

$A = (P)\ 10\ \text{cm.} - (R)\ 0\ \text{infinity} = 10\ \text{cm}$, or a lens

with a focal length of $\frac{100\ \text{cm.}}{10\ \text{cm.}} = +10\ \text{D.}$

Myopia.—E.g.

$$A = (P)\ 5\ \text{cm. or a lens of } \frac{100\ \text{cm.}}{5\ \text{cm.}} = 20\ D - (R)$$

$$20\ \text{cm. or a lens of } \frac{100\ \text{cm.}}{20\ \text{cm.}} = 5\ D.$$

A therefore $= 20\ D - 5\ D = 15\ D$.

Hypermetropia.—Patients require to accommodate to see for distance. Therefore P must be added to R.

E.g.

$A = P + R$.

$A = +2\ D$, which is the correction for distance, and has a near point of 20 cm., which is $\frac{100\ \text{cm.}}{20\ \text{cm.}} = 5\ D$. Therefore $A = +2\,D + 5\,D = 7\ D$.

Retinoscopy, or Shadow Test.—Retinoscopy is the means by which the surgeon is enabled to estimate the error of refraction which exists. The patient is placed in a dark room with a lamp directly over his head. The pupils are dilated with a mydriatic and the patient is made to look in the distance past the examining eye of the surgeon. The surgeon stands 1 metre away, and throws a light into the eye from a plane retinoscopy mirror, the observing eye being placed immediately behind the central hole. The red reflex of the fundus is seen. The mirror is then tilted slowly along the axes of the principal meridians, e.g. in the vertical and horizontal directions. If the patient is hypermetropic, the shadow, which passes across the red reflex of the fundus, moves *in the same direction* as that in which the mirror is tilted, since the rays reflected from the patient's eye have not come to a focus before they enter the eye of the observer. If the patient is myopic, the shadow moves *against the direction* of the mirror, as the rays reflected from the patient's fundus have not only come to a focus but have crossed before they enter the eye of the observer. The horizontal meridian is then

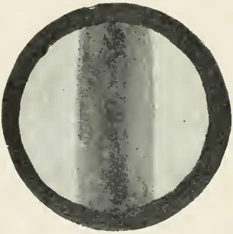
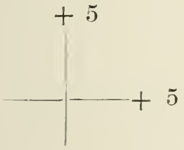


Fig. 17.—The appearance of the shadow in retinoscopy, the mirror is being moved in the horizontal direction.

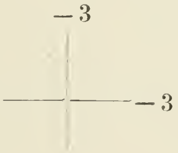
examined in the same way (Fig. 17). (If a concave mirror is used the shadows move in the reverse directions.) A spectacle frame is then adjusted on the patient's face, and glasses placed before the eyes until the shadow is neutralized ; that is to say, it is not possible to tell in which direction the shadow moves (either *with* or *against*). It is then noted on paper by a cross thus :—

A



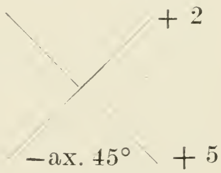
Hypermetropia, shadow moves with.

B



Myopia, shadow moves against.

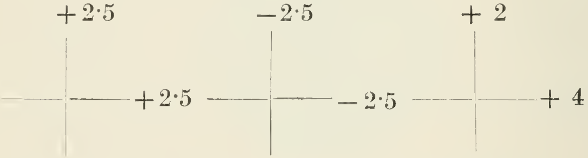
C



Hypermetropic Astigmatism.
Hypermetropia + 2.
Astigmatism + 3 D.

If a different strength of glass be required to neutralize the shadow in the two meridians, this difference in strength between the two lenses represents the amount of astigmatism present, the axis of the cylinder required to correct it being at right angles to the highest meridian. The exact position of the axis can be determined by putting the cylinder in the spectacle frame and turning it until the shadow is properly neutralized.

Theoretically speaking, the surgeon ought to be standing at 6 metres, since the patient is subsequently tested for that distance, so that ·5 D should be added to — spheres and ·5 D subtracted from + spheres for this fallacy. Thus the following figures will represent the true refraction—



$$= +2 \qquad\qquad = -3 \qquad = \frac{+1{\cdot}5\text{ D sph.}}{+\ 2\text{ D cyl. ax. vert.}}$$

In emmetropia the shadow will move in the same direction as the mirror, but is neutralized by a + ·50 sphere.

For theories which more fully explain retinoscopy a treatise on refraction should be consulted.

Hypermetropia is the condition in which parallel rays of light (objects over 6 metres) are not brought to a focus on the retina, but tend to converge towards a point behind it. It is usually due to a congenitally short eye—all infants are hypermetropic at birth. It may also be due to defect on the part of the media, as, for instance, in absence or complete displacement of the lens.

Symptoms.—Patients with this condition complain of difficulty in seeing near work. They try to overcome their error by accommodation, with the result that symptoms of headache and occasional blurring of words during reading are noticed, owing to exhaustion of the ciliary muscle. This may give rise to serious effects in the mental development of children. In old people, when accommodation has been lost, defect of both distant and near vision results. This may also occur in young people in high degrees of hypermetropia. The eye may appear small, especially the cornea, and the anterior chamber shallow. Hypermetropia may be manifest or latent.

Manifest Hypermetropia is the degree of hypermetropia present before paralysis of the accommodation. It is estimated by the highest + glasses that a patient will take to see clearly in the distance, and is expressed by the symbol Hm.

Total Hypermetropia is the amount of hypermetropia under a mydriatic.

Latent Hypermetropia is the difference between the total and the manifest, being the amount concealed by accommodation.

Thus Hm = + 2
Total = + 6
Latent = + 4

Tests.—Patients with hypermetropia see as well, or better, in the distance with a + glass before their eyes. Retinoscopy with a plane mirror shows the shadow moving in the same direction as the mirror.

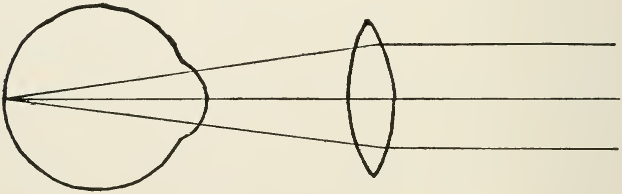


Fig. 18.—Showing the correction of hypermetropia with a convex lens. Note that the rays are made to converge before entering the eye.

Treatment.—By correction with + or convex lenses (Fig. 18). The amount ordered should be all the manifest with half the latent.

Thus

$$\left.\begin{array}{r}\text{Hm} + 1\\ \text{Total} + 6\\ \text{Latent} + 5\end{array}\right\} = + 3{\cdot}5 \text{ ordered.}$$

In children, where it is impossible to exercise subjective tests, two-thirds of the total hypermetropia estimated by retinoscopy is generally correct.

Presbyopia is due to the increasing sclerosis of the lens with age, whereby the range of accommodation becomes lessened. Presbyopia usually becomes apparent about the age of forty-five in the emmetropic. Patients are unable to see distinctly for reading, especially in the evenings.

Treatment.—The condition being due to gradual loss of the power of accommodation, this has to be supplied by + glasses in order to enable the patient to see distinctly at the requisite distance. For ordinary purposes, such as reading and sewing, + 1 for every five years after the age of forty-five up to the age of sixty (+ 4), when accommodation is lost completely, is required. If the patient be previously hypermetropic or myopic, these lenses must be added or subtracted, thus—

A patient aged fifty-five and emmetropic will require + 3.

A patient aged fifty-five and hypermetropic + 2 will require + 5.

A patient aged fifty-five and myopic — 2 will require + 1.

Myopia is the condition in which parallel rays (and rays from over 6 metres) are brought to a focus before they fall on the retina. In other words, the far point is reduced from infinity to comparatively close up to the eyes, depending on the amount of myopia. Thus a myope of 5 D has a far point of 20 c.m. (that is $\frac{100}{5}$ cm.). Objects within this range are clear, but beyond they are indistinct.

Myopia is, therefore, always an acquired condition, and may be due to (1) increase of length in the globe, especially the posterior segment; this is known as axial myopia; or (2) an alteration in the refractive index of the media, as in early cataract.

Axial Myopia.—The chief factors in producing axial myopia are—

1. Excessive accommodation and convergence as the result of education ; long hours at lessons in a faulty stooping position, and reading in a bad light, so that the books, etc., used are placed too close to the eyes. Patients with opacities in the cornea or lens place their books as near as possible, for the purpose of securing a large retinal image and for the same reason develop myopia.

2. Weakness of the sclerotic.

(*a*) Hereditary, myopia frequently running in families.

(*b*) As the result of disease, for instance, scleritis and choroiditis, leading to softening and stretching of the sclerotic.

Varieties.—Although no distinct lines can be drawn between these two forms, they are for the sake of description divided into (1) simple, and (2) malignant.

Simple myopia is a slow progressive increase in the refractive error which ceases when adult life is reached. It is usually under 6 D of myopia.

Malignant or progressive myopia is a condition in which the refractive error progresses in spite of treatment and throughout life, with the result that the posterior pole of the globe becomes so stretched and atrophic that blindness results. Not infrequently in extreme cases the lens becomes cataractous as the result of malnutrition.

Symptoms.—Patients with myopia are unable to see in the distance. If the far point is very near their eyes the patients may develop a stoop as the result of poring over their work. They frequently screw up their eyes in order to cut off some of the peripheral rays of light. Not infrequently myopes of low degree can improve their vision by rubbing their eyes, the rubbing no doubt causing some flattening of the globe reducing the refractive error. The eyes themselves may look big, the pupils large and the anterior chamber deep.

Tests.—Patients are improved for distance with – glasses. With a plane retinoscopy mirror the shadow moves against the tilting of the mirror.

By the direct ophthalmoscopic examination the fundus cannot be brought into view without correcting the refractive error with a – glass behind it, and when seen is under a much higher magnification than normal. With the indirect method the fundus is easily seen.

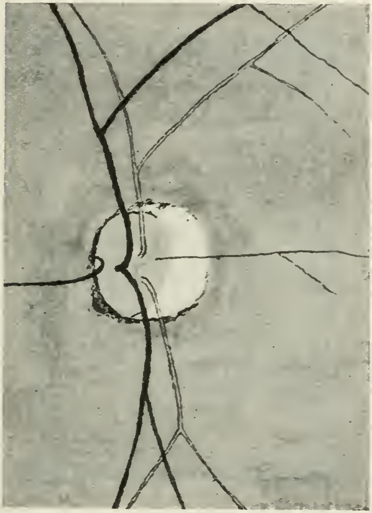


Fig. 19.—Myopic Crescent.

The stretching and atrophy at the posterior pole of the globe may produce the following conditions:—

1. In the early stage, a white *crescent*, seen on the outer side of the disc (Fig. 19).

2. The crescent extends around the disc until it completely encircles it. It is then known as an *annular staphyloma*.

3. Splitting and hæmorrhage in the choroid behind the macula.

4. Retinal detachment.

Treatment.—1. *General.* 2. *Local.*

1. GENERAL TREATMENT.—*Prophylaxis.* The greatest care should be taken that children are provided with proper school desks, so that the head can be kept in an upright position, and as far away from the work as possible. The light should be arranged so that it falls directly on the work from the right hand side. In all cases of myopia the patient should be put under the best physical conditions in order to improve the general health.

2. LOCAL TREATMENT consists in (*a*) the ordering of proper glasses, and (*b*) operative measures.

(*a*) *Glasses.*—The lowest concave glass with which the patient can see distinctly in the distance is the measure of the myopia (Fig. 20). In most cases, especially in children, it is advisable to use a mydriatic for estimating the extent of the error. The full correction should be ordered for distance in all cases. Patients with myopia, unless young, frequently have defective accommodation owing to the limited use of the ciliary muscle. They frequently, therefore, require separate glasses for reading, which are best found by testing each patient individually for the distance at which he desires to see. This is usually, for reading, about 3 D less than the full correction. In cases of rapidly progressing myopia the eye should be kept at rest under atropine and dark glasses worn for six months or more whilst the general health is attended to.

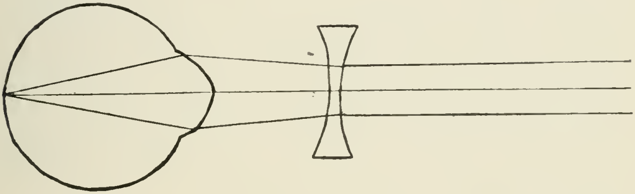


FIG. 20.—Showing the correction of myopia with a concave lens. Note the rays are made to diverge before entering the eye by means of the concave lens.

(*b*) *Operative measures.*—Removal of the lens for myopia of over 18 D gives very satisfactory results and improvement of vision in selected cases ; indeed a full normal distance vision has been obtained without glasses, but + glasses were required for reading. The operation is only justifiable under certain circumstances, the chief of which are—

(1) The amount of myopia should be over 18 D.

(2) The defect in distant vision should be less than $\frac{6}{18}$ with the correcting glass.

(3) Ophthalmoscopically the macular region must be sound.

(4) Binocular vision should be absent.

(5) The patients should be children or young adults.

(6) Some serious reason preventing the patient from wearing glasses.

Needling as for lamellar cataract (see p. 337), is the best operation. The lens is absorbed slowly, and it is best to avoid evacuation if possible.

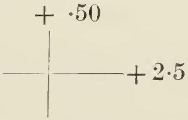
The chief objections to the operation are—

(1) That there is always a small risk of septic

infection—sympathetic ophthalmia has been known to occur.

(2) That retinal detachment seems rather more common after the operation than in ordinary myopes of the same degree.

Astigmatism is an inequality of the refractive media so that the rays of light are not brought to a common focus on the retina. The defect is usually situated in the cornea, the curve in one portion of the cornea being greater than in the other. Occasionally the lens is also at fault. Astigmatism is divided into :—(1) Irregular astigmatism, in which the irregularities are in the refractive media, as for instance in corneal nebulæ. (2) Regular astigmatism, in which the asymmetry lies in two main planes, the difference in refraction between the two being the amount of the astigmatism present.

(*a*) **Simple Astigmatism** is the form in which one of the meridians is emmetropic, thus 

= + 2 D of hypermetropic astigmatism, axis vertical.

(*b*) **Compound Astigmatism** is the form in which one meridian is hypermetropic or myopic, and the other meridian has a greater amount of hypermetropia or myopia.

+ 5·5

+ 2·5 = + 2 of hypermetropia and + 3 D of astigmatism axis horizontal.

(*c*) **Mixed Astigmatism** is the form in which one meridian is hypermetropic and the other meridian is myopic.

− ·50

+ 3·5 = 4 D of mixed astigmatism.

Symptoms.—1. Defective vision ; that is to say, patients with any large amount of astigmatism cannot see $\frac{6}{6}$.

2. Headaches and other symptoms of asthenopia.

3. Patients may look sideways, so as to diminish the amount of their refractive error in one meridian.

Diagnosis.—When vision cannot be brought to the full $\left(\frac{6}{6}\right)$ with spherical glasses, astigmatism should be suspected. Cases of headache associated with low degrees of hypermetropia are frequently complicated by low degrees of astigmatism, for which they should be examined carefully.

Tests.—1. *Retinoscopy* is by far the most important of all the tests, since it shows the degree of error both in the cornea and lens. The difference between the two glasses used to neutralize the errors in the two meridians represents the amount required to correct the astigmatism.

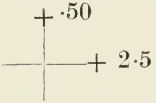
2. The improvement of vision with cylindrical glasses.

3. Testing with the astigmatic clock face reveals the fact that some lines are more distinct than others. For a similar reason, a slit placed before the eye will show the test type much more clearly when the slit is in one direction than in the other.

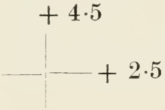
4. *The ophthalmoscope* shows that the vertically placed vessels have a different focus from those arranged horizontally.

5. *The ophthalmometer*, an instrument for measuring the corneal curvature, shows that there is a difference in curvature in two main directions.

Treatment.—Full correction of the error with cylinders for constant wear is the best method of treatment, the axis of the cylinder being placed at right angles to the greatest curvature. In hypermetropic astigmatism the axis of the cylinder is usually vertical and is then spoken of as being "with the rule"; if horizontal "against the rule." In myopic astigmatism it is usually horizontal, and is then spoken of as being "with the rule"; if vertical "against the rule." Thus examples may be taken—

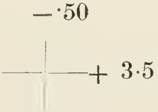


$= +2$ D cylinder axis vertical. Simple hypermetropic astigmatism (with the rule).



$$= \frac{+2\text{ D sph.}}{c + 2\text{ D cylindrical axis horizontal.}}$$

Compound hypermetropic astigmatism (against the rule).



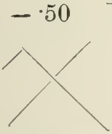
$$= \frac{-1\text{ D sph.}}{+4\text{ D cyl. axis vert.}} \text{ or}$$

$$\frac{+3\text{ D sph.}}{-4\text{ D cyl. axis horizontal.}}$$

This last example is a case of mixed astigmatism, showing the two different methods of combining glasses for its correction. It is as a rule desirable to keep the axis vertical, if possible, so as to avoid any distortion in looking downwards through the edge of the cylinder when placed horizontally. The first method would have been the best for ordering, in addition to which the lenses also would not have been so thick.

Although the axes of cylinders are very frequently either vertical or horizontal, they may be required at any angle. Thus—

Left eye.



$$= \frac{-1\ \text{D. sph.}}{-3\ \text{D cyl. ax. 60 down and out.}}$$

Patients often have some difficulty in wearing cylindrical glasses at first, and should be warned that they may cause discomfort for a time. In high degrees of astigmatism in young people the instillation of a mydriatic is sometimes necessary when first the glasses are worn, owing to the spasm of accommodation which is not infrequently associated with the condition.

Anisometropia is the difference in refractive error in one eye from the other. It is usually a difference in degree of the same error, but occasionally one eye is hypermetropic and the other is myopic. In extreme degrees, binocular vision is often absent, and in these cases correction of both eyes will often cause discomfort; consequently, if it is only possible to correct one eye, the one having the better vision should be selected. Occasionally these patients use one eye for reading and the other for distance; thus a patient may be emmetropic in the left eye and -4 D in the right, in which case he will require no glasses, using the left for distance and the right for reading.

Method of testing Patients for Glasses.—*Snellen's test types* (Fig. 21) are used for testing distant vision. They are graduated so that the letters at the distance marked over each line subtend an angle of 5° on the retina (the distance between two cones); that is to say, if a patient sees the row marked 6 at 6 metres $\left(\frac{6}{6}\right)$ his vision is 1 or normal. The same applies if he sees the top letter marked

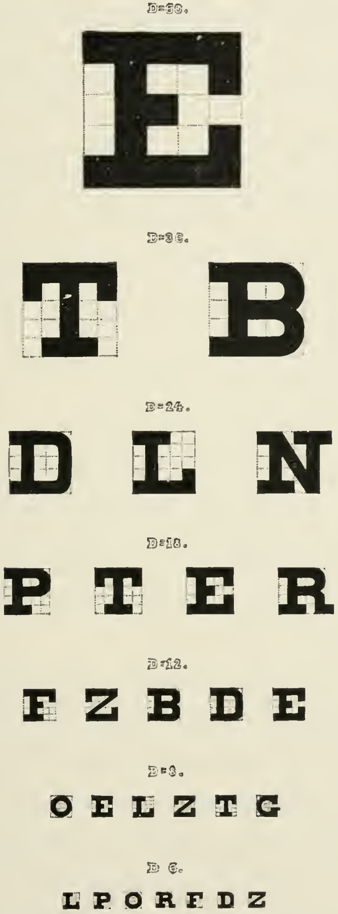


FIG. 21.—Snellen's test types.

60 at 60 metres. He therefore can see $\frac{60}{60}$ of normal vision, or 1. But if he can only see the top letter at 6 metres he has $\frac{6}{60}$ or $\frac{1}{10}$ of normal vision. The same applies for the other rows of letters on the board.

Jaeger's types (symbol J) are used to determine the reading distance or near point. The numbers over the paragraphs represent the size of the type. Thus a patient may see J1, J2, J4.

Patients should always be tested for distance and near vision, since the near vision may not only show a hypermetropic or presbyopic error, but may also reveal paralysis of accommodation, as in diphtheria.

Distance vision.—The patient is placed at 6 metres (20 ft.) distance away from a Snellen's test type, which should be well illuminated. Where a room of sufficient length is not available a mirror can be used—which has the effect of doubling the distance. A spectacle frame is placed on the face and one eye occluded by means of an opaque disc. The patient is asked to read down the board as far as he can and his vision is recorded. If he be unable to see the top letter, which is $\frac{6}{60}$, he is told to walk up to the board until the top letter is brought into view, and the number of metres is then recorded, as for instance $\frac{1}{60}$ at 1 metre. If the patient cannot see letters at any distance a hand is held before the eye and he is asked to count the fingers. If he is still unable to do this the perception of shadows between the eye and the light should be tried; failing this whether he can perceive light from darkness. This latter test should be very carefully carried out, since blind patients sometimes think they are able to see light, whereas they cannot really do so.

If the patient sees $\frac{6}{6}$ a low + glass is placed in front of the eye and he is asked if he can still see distinctly, since it is possible for a hypermetrope to see $\frac{6}{6}$, and overcome his error by the action of accommodation. The + glasses are increased in strength until the highest glass is obtained with which he can see $\frac{6}{6}$ distinctly, and is recorded thus : $\frac{6}{6}$ + 1 Hm.

If the patient is unable to read $\frac{6}{6}$ a low + and a low – glass are given to him alternately and he is asked with which glass he can see the better. The strength of the glass which he selects is then increased until no further improvement takes place. Thus :

$$\text{R.V. (right vision:)}\ \frac{6}{24}\ \bar{c} + 2 = \frac{6}{6}$$

If the patient says that the two glasses shown to him are alike, it is the highest + or the lowest – which is nearer the measure of his refraction.

If the patient still cannot see $\frac{6}{6}$ some astigmatism may be present, and it is then desirable to use a mydriatic.

Mydriatics should also be used in cases of suspected latent hypermetropia or spasm of accommodation ;

the only exception being when glaucoma is suspected, and it is therefore on this account advisable to instil eserine after the use of a mydriatic in patients over forty. Atropine should be used in all children up to the age of sixteen, and should be given in the form of drops, or preferably as ointment, three times for three successive days before the patient is seen again. Homatropine and cocaine may be used in patients over the age of sixteen, three or four applications being instilled half an hour before examination.

When the pupil is dilated and the accommodation paralysed, the patient is taken into the dark room and the amount of refractive error estimated by retinoscopy. A further examination is then made with the test types in order to verify the correction by retinoscopy. This estimation of the refraction in small children or in patients who are dull is probably more accurate than the test type method. On the other hand even the most experienced observers may be $\frac{1}{2}$ D out by retinoscopy, especially in myopia, so that the subjective test in an intelligent patient is often more reliable ; but both methods should be employed in every case where possible.

Having determined the refractive error in this way, glasses may be ordered on the lines previously laid down. In cases of doubt, the patient should be seen again after the effect of the mydriatic has passed off. The fundus and media should be very carefully examined in all cases, especially where, after retinoscopy and correction, $\frac{6}{6}$ vision is not obtained. If no disease is found the patient should be examined for tobacco amblyopia, retro-bulbar neuritis, congenital amblyopia, hysteria and malingering.

In cases where asthenopia is still present after the correction of refraction, or the error is insufficient to account for the symptoms, the patient should be examined for muscular errors (Maddox rod test, see p. 277).

Finally, the general health and the conditions under which he follows his occupation should be inquired into.

Glasses should be worn constantly—

(1) In all cases of myopia, except for reading in low degrees.

(2) In all cases of hypermetropia and astigmatism in which the vision does not reach $\frac{6}{6}$ without correction.

(3) In all cases of headache in which, even when $\frac{6}{6}$ is present without glasses, the symptoms are not relieved by wearing them for reading only.

Glasses should be worn for reading only—

(1) In cases of presbyopia.

(2) In cases of hypermetropia when $\frac{6}{6}$ is obtained without a glass.

Lenses are made either " round " or " round oval." Large round lenses are most suitable for children, as they cannot look over them. In cases where a different glass is used for distance and reading they may be combined by the addition of the + glass to the lower segment. These lenses are known as bi-focal or Franklin's glasses. Toric lenses are lenses which are curved to the surface of the eye, and give rather a larger field.

Frames.—Spectacles should always be ordered for children and fixed behind the ears by means of hooks. Spectacles for presbyopia usually have straight sides.

Pince-nez folders are convenient for presbyopia; but should never be worn by patients with astigmatism. For these cases a rigid bridge is necessary to keep the axis of the glass accurate.

Measuring for Glasses.—(1) The distance between the pupils is taken, and the optical centres of the lenses should correspond to this measurement, depending on whether they are required for distance or for near.

(2) The height of the bridge of the nose should be taken.

(3) The length of the side wires, if spectacles are worn.

The latter two points are best judged by having a number of frames to try on.

CHAPTER III

DISEASES OF THE CONJUNCTIVA

Anatomy.—The Conjunctiva is a membrane which covers the posterior surface of the eyelids (tarsal conjunctiva) and the anterior surface of the globe (bulbar conjunctiva), while at their point of junction above and below it is thrown into folds (upper and lower conjunctival fornix). The point where the conjunctiva joins the cornea is called the limbus. The conjunctiva, therefore, is a closed sac opening on the surface by a slit-like aperture, the palpebral fissure.

The tarsal conjunctiva is exposed by drawing down the lower lid and everting the upper.

To evert the upper lid.—Make the patient look strongly down, seize the eyelashes with the thumb and forefinger of the left hand, push down with the thumb of the right hand the skin of the upper lid above the tarsal plate ; then evert by pulling the lid upward against the point of the thumb.

The conjunctiva in this situation is intimately adherent to the tarsal plate, and therefore cannot be drawn together after the removal of portions of the membrane by accident or operation. The Meibomian glands can often be seen through it as white streaks running down towards the lid margin. Close to the upper lid margin a furrow can be seen (the sulcus subtarsalis), a favourite situation for the lodgment of foreign bodies.

The conjunctiva of the fornix is very loose in structure and thrown into multiple small folds, whilst the *bulbar conjunctiva* is also very elastic, but is attached at the corneal margin (limbus).

Histologically the conjunctiva is divided into two layers : (1) *The epithelium*, which is stratified, varying slightly in thickness in different regions. It is unlike the skin in being much thinner, and does not, under normal conditions, contain prickle or keratin cells. Many of the cells are often found undergoing mucoid change, which is most marked in the folds of the fornices ; these are enormously increased in inflammation. The conjunctival secretion is also added to by two types of glands which open on to the surface of the conjunctiva at the upper border of the tarsus; these are—

A. Mucous.—Henle's glands and newly formed mucous glands in the epithelium.

B. Lachrymal, Krause's, glands of Waldeyer (acino-tubular glands).

(2) *The subepithelial tissue* varies in different regions. In the fornices there is a thick layer of adenoid tissue which is practically absent from the palpebral conjunctiva, and entirely so from the bulbar conjunctiva. The bulbar conjunctiva and that of the fornices are rich in elastic tissue, whilst the palpebral conjunctiva contains practically none—a fact which is very evident when operating on it.

The blood supply is derived from two main sources—

(1) From the facial artery by the tarsal arches; two in the upper and one in the lower lid which supply the tarsal and part of the conjunctival fornices.

(2) From the ophthalmic artery by the posterior

conjunctival branches, and from the anterior ciliary vessels, which principally supply the conjunctiva covering the globe. It is important to distinguish the latter two vessels in diagnosing iritis from conjunctivitis. In the former the anterior ciliary vessels are full, causing a dusky bluish flush around the cornea, whilst in the latter more distinct individual vessels of bright colour, covering the whole bulbar conjunctiva, are seen.

THE CHANGES PRODUCED BY INFLAMMATION IN THE CONJUNCTIVA.

The normal conjunctiva is sterile in about 50 per cent. of cases, and in the other cases the organisms which it contains are not as a rule virulent. The most common organisms to find are the so-called xerosis bacillus and staphylococcus albus. The conjunctiva undergoes considerable alteration with age and after inflammation. In the new-born child it is smooth and contains no mucoid glands. The epithelium is thinner and often much eroded in the fornices, and there is no layer of lymphoid tissue—facts which render it

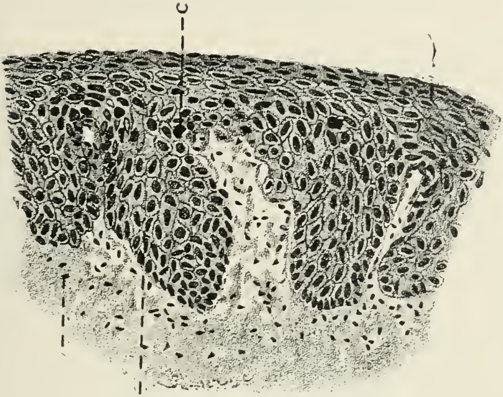


FIG. 22.

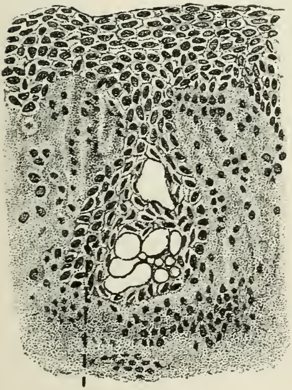


FIG. 23.

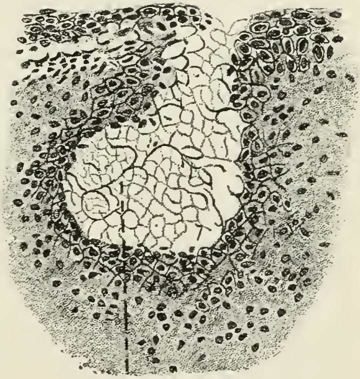


FIG. 24.

FIGS. 22, 23, 24.—Showing the process of new gland formation in the conjunctiva.

22.—Papillary formation, *C*.

23.—Commencing mucoid change in epithelium, *A*.

24.—New gland formed by complete mucoid change in the epithelium, *B*.

more liable to infection. In old age and after recurrent attacks of inflammation the tarsal conjunctiva becomes velvety in appearance ; this is due to the formation of papillæ, and there is an increased mucoid degeneration in the folds formed between these papillæ, with the result that definite new mucous glands are formed (Figs. 22, 23 and 24). Not infrequently these glands get blocked at their mouth, with the result that a small cyst filled with mucous and epithelial débris is formed ; these appear like millet seeds and often undergo calcareous change. Sometimes many hundreds of them may be seen in one conjunctiva.

When the conjunctiva is inflamed for any length of time there is a great increase in the lymphoid tissue, not only in the fornices, but also elsewhere ; first in the palpebral conjunctiva and then in the bulbar conjunctiva at the limbus. This increased call on the lymphoid cells results in the formation of lymphoid follicles, which are identical with those which are found in lymphatic glands, and, like the follicles in the conjunctiva, can also be of new formation. These follicles are first formed in the fornices, but vary in situation with the cause of inflammation. Thus, in trachoma, they are found chiefly in the upper fornix, whilst after other forms of inflammation such as Koch-Week's, diplobacillary or staphylococcal conjunctivitis, they are found in the lower fornix. Before the identification of organisms as the cause of the various forms of conjunctivitis they were all known as *follicular conjunctivitis* (Fig. 25). In children follicles seem more prone to form as the result of irritation than in adults. This is probably due to the fact that all lymphoid

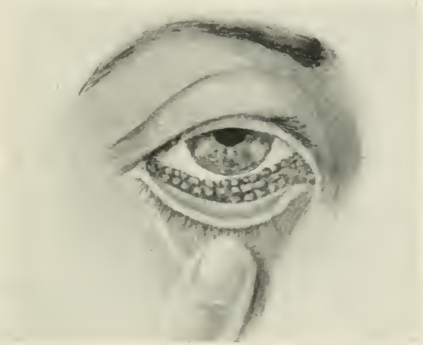


Fig. 25.—Follicular formations in the lower fornix—so-called follicular conjunctivitis.

tissue is much more active in children (e.g., adenoids and tonsils, etc.).

Injuries.—Foreign bodies lodged in the conjunctival sac, unless embedded in the conjunctiva, are usually found by the surgeon under the upper lid—the sulcus subtarsalis being a favourite situation. They are easily removed by a spud or needle, a drop of 4 per cent. cocaine being first instilled. Subsequently the eye should be bandaged for a few hours until the effect of the cocaine has passed off, as the patient in wiping the eye may wipe off the epithelium of the cornea whilst it is insensitive from the cocaine.

A peculiar nodular condition of the conjunctiva known as *ophthalmia nodosa*, occurs as the result of getting certain forms of caterpillars' hairs into the conjunctival sac.

Wounds of the Conjunctiva occur as the result of injury and operation. Wounds of the bulbar conjunctiva, if at all large, gape widely, owing to its elasticity, and therefore should be brought together with a suture. When aseptic they heal readily, uniting firmly in from forty-eight hours to three days.

Subconjunctival Hæmorrhage occurs from two *causes* :—

A. Local hæmorrhage. *B*. Orbital hæmorrhage.

A.—Local hæmorrhage. (1) Injury, after a blow, although there may be no history, such as a blow which may be received during an epileptic fit, or during sleep.

(2) Straining, as in coughing (whooping cough), and great physical exertion; this is more liable to take place in old people with degenerated vessels.

(3) As a sequela of conjunctival inflammation, e.g., Koch-Week's conjunctivitis.

B.—Orbital hæmorrhage may appear after fracture of the base of the skull or orbit.

Diagnosis is usually easy, since orbital hæmorrhage, due to a fractured base, appears in the lower sac first, is much more profuse, does not appear for some little time after the injury, and increases slowly, often causing some proptosis.

Treatment.—*Local.* A "placebo" of boracic lotion may be given, the ecchymosis disappearing in from one to four weeks. If a fracture of the skull or orbit is present it must be treated accordingly.

Burns may arise from fire, chemicals, more especially lime and acid, molten metals, etc., or even an intense light on the eye. They occur most usually on the ocular conjunctiva and appear as greyish-white patches which are followed by intense chemosis and discharge.

Treatment.—Cocaine to relieve the pain is first instilled. The conjunctival sac is thoroughly cleansed. In the case of lime burns a solution of sugar is the best fluid to use, as it forms an insoluble compound with the lime ; acid burns require a solution of bicarbonate of soda. Atropine ointment is then applied to the conjunctival sac. If the burn is at all extensive great care must be taken to prevent the union of the lid to the globe (symblepharon). In very extensive cases grafting of mucous membrane from the mouth may be necessary.

Inflammation of the Conjunctiva (ophthalmia) may be divided into—

(1) Acute. (2) Chronic.

Certain forms of the acute inflammation may become chronic—such as that produced by the Morax-Axenfeld bacillus.

(1) ACUTE.

(*a*) **Diplobacillary Conjunctivitis**, or angular conjunctivitis, is an inflammation set up by the infection of the conjunctival sac with the Morax-Axenfeld bacillus. The organism, which is easily found in the discharge, is a large bacillus found in pairs, end to end, staining readily with methylene blue and decolourized by Gram's method. When grown on blood serum (or media containing blood) it causes characteristic pits on the surface, from which it has been called "bacillus Lacunatus" (Fig. 26).

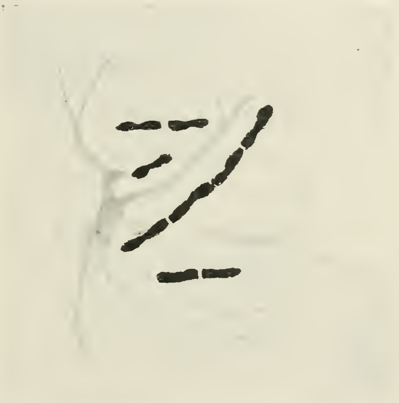


FIG. 26.—Diplobacilli from a case of angular conjunctivitis.

Ætiology.—The disease is extremely contagious ; it is carried in dust, and hence is frequently seen amongst hospital porters and scrubbers. The infection is not infrequently carried by towels, sponges, water, etc. ; indeed, it may occur in epidemic form amongst schools, asylums, etc.

Symptoms are those of the condition which used to be known as *catarrhal ophthalmia.* The patient complains of gritty, itching or burning sensations in the eyes, and in the morning on wakening the eyelids are often gummed together with secretion.

Diagnosis.—The appearance of the patient is characteristic. The conjunctiva, especially the palpebral, is red, often slightly swollen, and if the condition has lasted some time there may be a few follicles in the lower fornix. But the most characteristic features are the red angles to the eyelids, the whole palpebral margin being sometimes affected —hence the term angular conjunctivitis, which has been applied to this condition. The secretion is greyish-white in colour and is *non-purulent,* that is unless pyogenic organisms are also present, mixed infection being very frequent.

Course and Complications.—Without treatment the disease does not get well, and becomes chronic. It is probable that this organism, usually associated with the staphylococcus, is the principal cause of the chronic blepharitis and conjunctivitis so frequently seen amongst children of the lower classes. Small grey marginal corneal ulcers are a not infrequent complication.

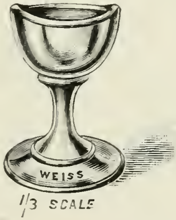


FIG. 27.—Eye bath.

Treatment.—The patient should be warned of its infectious character, and necessary precautions taken to prevent its spread. The specific for the disease is sulphate of zinc, which can be given as a lotion, grs. i to iij to the oz. with grs. x of boric acid, to be used six times a day. A little boric ointment should be smeared along the lid margins at night-time to prevent gumming of the lids. It usually takes from three to six weeks to get well, depending on the length of time it has existed (Fig. 27).

(*b*) **Koch-Week's Conjunctivitis** is a purulent conjunctivitis of moderate severity, caused by a small bacillus closely allied to the influenza bacillus, which is found in the discharge in the early stages; in the later stages it tends to disappear. The organism stains faintly with methylene blue and is decolourized by Gram's method; it can be grown on media containing blood and on weak agar (·5 per cent.) forming small round white colonies. This bacillus is the commonest cause of purulent ophthalmia (Fig. 28).

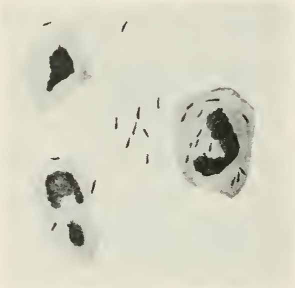


Fig. 28.—Koch-Week's Bacillus. The commonest cause of purulent ophthalmia.

Ætiology.—It is the cause of nearly all the outbreaks of epidemic ophthalmia in this country, its spread being conveyed, as in diplobacillary conjunctivitis, by towels, water, etc.

Symptoms.—The disease almost always affects both eyes, though one may be affected before the other. There is a profuse purulent discharge, with intense injection of both ocular and palpebral conjunctiva, and practically no chemosis, except in young children who are out of health. One of the main characteristics is the occurrence of hæmorrhages which are visible in the ocular conjunctiva. Phlyctenulæ are very frequently present. Towards the end of the attack follicles appear in large number in the lower fornix, and remain a considerable time after the discharge has ceased.

Diagnosis can usually be made from the clinical appearance, but in any case of doubt a microscopic examination will usually settle the point, although the organisms are difficult to find.

Course.—If left alone the disease will, in course of time, get well of itself. If one eye only be affected it almost always spreads to the other eye, owing to its great infectivity. Although it is perhaps the most common cause of phlyctenulæ it is rare for the cornea to become involved.

Treatment.—Constant washing away of the discharge with boric lotion and smearing unguentum boracis along the lid margins to prevent them sticking together, combined with the use of protargol 10 per cent, as drops twice a day, is usually effectual in bringing about a cessation of the discharge in seven to ten days.

(*c*) **Gonorrhœal Conjunctivitis** exists in two forms—

1. In the new born (ophthalmia neonatorum) ; 2, In adults. Although the two diseases are due to the same organism, the clinical appearance and prognosis of the disease differs in the two cases, owing to the alteration in structure of the conjunctiva and cornea which takes place in the adult. The incubation period is about seventy hours. In both forms the gonococcus is easily found in the discharge in large numbers (Fig. 29).

(1) **Ophthalmia Neonatorum.**—Of all diseases of the eye there is none which causes more blindness. It is the cause in 27 per cent. of all the cases admitted to

the blind schools of England; this is a very high proportion, considering that the disease can be entirely prevented and eradicated without injury to the sight if proper prophylactic and other treatment is stringently carried out.

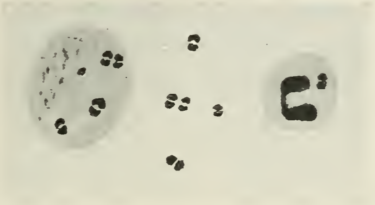


FIG. 29.—Gonococci in the discharge from a case of ophthalmia neonatorum.

Ætiology.—The gonococcus is the cause of 60 per cent. of the cases, and indeed, practically the only cause when the affection is of such severity as to give rise to corneal complications. The other organisms which make up the remaining 40 per cent. are the staphylococcus, bacillus Morax-Axenfeld, and more rarely, bacillus coli communis, streptococcus, pneumococcus, bacillus Klebs-Loeffler, and bacillus Koch-Weeks.

Infection of the infant's eyes from the vaginal discharge of the mother may take place—

(1) In utero—children having been born with fully developed ophthalmia neonatorum and ulceration of the cornea.

(2) During or immediately after birth—the most common time at which infection takes place.

(3) Some time after birth (secondary infection)—from the discharge on towels, etc.,

Diagnosis.—The diagnosis is usually very simple, but there is one condition, really a complication of the disease, for which it may be mistaken; viz: congenital lachrymal obstruction with a large purulent mucocele. In these cases usually one eye only is filled with pus, whereas ophthalmia neonatorum generally affects both eyes. Pressure over the lachrymal sac will cause regurgitation of pus into the eye and so render the diagnosis easy. As a rule, although the sac may be very distended, there is no swelling to be seen over the lachrymal area, as the fat cheeks of the infant hide it.

Symptoms.—The eyelids are red and swollen, and there is a thick creamy discharge, usually from both eyes, coming on most frequently about the third day after birth, this however, depending on the time at which infection has taken place.

When a child is brought with ophthalmia neonatorum the greatest care should be exercised in the separation of the lids, since it is impossible to say what the condition of the cornea may be, and any undue pressure on the globe may lead to the rupture of an ulcer which is on the point of perforating.

The baby should be held by a nurse, the head being placed on or between the knees of the surgeon, who should wear protective glasses to prevent any chance of infection of his own eyes. Naturally the most careful antiseptic precautions with regard to the hands, etc., should be observed after examining such a case.

Having separated the eyelids and washed or wiped away the discharge, the cornea should be first examined, for if it is found to be clear a good prognosis may be given. The palpebral conjunctiva in severe cases is red and swollen, and its surface is much papillated. Occasionally in mild cases there is much follicular formation, especially in the lower fold. The ocular conjunctiva, as a rule, is not so much affected, and gonorrhœal cases in infants, unlike those in the adult, show practically no chemosis, which is probably due to the fact that the eyes are always closed, whilst in the adult the ocular conjunctiva in the palpebral fissure is principally œdematous, owing to the swollen lids causing a certain amount of constriction.

It is impossible to say with certainty, without a bacteriological examination, what organism is the actual cause of the infection, but if a case comes with a profuse, thick, creamy discharge which, in the later stages, becomes flocculent with a very little mucus in it, one can almost with certainty say that it is gonorrhœal, more especially if the cornea is affected, since the other organisms do not as a rule attack the cornea with the exceptions perhaps of the streptococcus and the Klebs-Loeffler bacillus.

On the other hand, if a case comes with a slight discharge and red lid margins, the skin around the lids being involved, the infection is probably due to the Morax-Axenfeld bacillus. This latter organism rarely occurs alone in infants, but is usually associated with the staphylococcus albus, and therefore, contrary to that found in adults, the discharge is often a slightly purulent one.

Conjunctival false membranes are not at all infrequent in infants, and are not necessarily of of diphtheritic origin.

Treatment.—*Prophylaxis* plays a most important part in the prevention of ophthalmia neonatorum. Credé, who introduced the method known by his name, reduced the percentage of ophthalmia neonatorum in the Leipzig Lying-in Asylum from 10·8 to ·1 per cent. The method now most commonly adopted is in every case to wipe the eyelids directly the child's head is born, then as soon after birth as possible the eyes are washed out with a solution of 1–2,000 perchloride of mercury. If the mother is known to have had a vaginal discharge before birth, douches should be given before rupture of the membranes and in addition to the use of the perchloride of mercury, silver nitrate, 2 per cent., should be instilled into the eyes, and subsequently neutralized with salt solution, as infants at birth have no lachrymal secretion.

There can be no doubt that the sheet anchor of the treatment is nitrate of silver. In cases of any severity, a 2 per cent. solution is painted once daily over the lids and fornices In mild cases protargol, 10 per cent. solution, can be used as drops at home if properly instilled. In the intervals the conjunctival sacs should be washed out every hour with a solution of 1 in 6,000 perchloride of mercury. The lotion should be used cold, or even iced, as cold inhibits the growth of the gonococcus, and at the same time prevents excessive swelling of the lids. In painting, wool mops on the end of glass rods, which should subsequently be carefully sterilized, are used. The nitrate of silver should be rubbed into the conjunctiva of the tarsus and fornix, so that the drug may reach the bottom of the papillæ, which are very marked in the gonococcal form of the disease, the excess of silver being neutralized with salt solution; the greatest care must be taken not to damage the corneal epithelium. A supply of wool, which must be burnt directly after use, should be given to the nurse to wash away the discharge from the patient's eyes. The nurse should be warned against the risks of infection and the greatest care must be taken whilst washing the child to cleanse the head separately and to keep all towels, sponges, etc., intended for its use entirely apart. If only one eye be affected care should be exercised in order to prevent the spread of infection to the other. The sound eye should be covered by a Buller's shield, or better perhaps in infants, by cyanide gauze sealed down on the nasal side by flexile collodion or strapping. It should be inspected for the first few days to see that infection has not taken place. The treatment should be continued with the lotion for at least a month after all the discharge has ceased, since the gonococcus has been found in the conjunctival sacs twenty-eight days after the discharge has subsided.

The duration of treatment varies considerably, according to whether the case is severe or mild. If mild, the case is usually free from discharge by the end of the second week of treatment ; if severe, as in the gonococcal form, the average duration of treatment is about six weeks.

The cornea is affected in about 27 per cent of all the cases of ophthalmia neonatorum; it should be treated as described under suppurative keratitis, p. 136.

(2) **In the adult form of Gonorrhœal Ophthalmia** infection of the conjunctiva is usually directly from the urethra, but may arise indirectly from using towels, etc., of infected persons.

The symptoms come on in from one to three days, depending on the severity of the infection. The eyelids look red, hot and swollen and, unlike the disease in infants, the conjunctiva shows intense œdema, with the formation of a sulcus around the limbus in which discharge may collect and lead to infection of the cornea. The secretion at first is thin blood-stained serum, followed in about forty-eight hours by a purulent discharge ; in about three weeks this discharge gradually diminishes in quantity until a complete cure is brought about. Unfortunately, unlike ophthalmia neonatorum, a good prognosis cannot always be given, as the cornea is much more liable to be infected either from the discharge lying in the sulcus around the limbus, or from injury to the corneal epithelium during treatment. The structural difference of the adult cornea from that of the child probably renders it less able to withstand the infection.

Treatment.—All persons suffering from gonorrhœa should be warned of the danger of infection of the eyes.

Silver nitrate, 2 per cent., should be applied daily to the conjunctiva; the discharge washed away by 1–6,000 perchloride of mercury every hour. Similar precautions should be ordered during treatment as for ophthalmia neonatorum.

Diphtheritic Conjunctivitis.—All cases of membranous conjunctivitis are not due to the Klebs-Loeffler bacillus; the streptococcus, gonococcus, and even the Koch-Weeks bacillus will at times cause a membrane which is indistinguishable from true diphtheritic membrane without the aid of the microscope.

Symptoms and Diagnosis.—Diphtheritic conjunctivitis may, or may not, be associated with a membrane in the throat or nose. Often patients present excoriations covered with membrane at the angles of the lids or on the face. A history of sore throat or of an epidemic of the disease is frequently obtained. On examination the lids are swollen and red, the preauricular gland enlarged, the conjunctiva is covered with a profuse adherent greyish membrane, associated with a purulent discharge in which the typical Gram-staining Klebs-Loeffler bacillus is found, usually in enormous numbers. The bacilli are frequently in such great quantities that the smear preparation is sufficient to make a diagnosis, but it must be remembered that the so-called xerosis bacillus is identical in appearance on culture, so that inoculation is the only means we have of verifying the diagnosis from a cultivation of the organism. In extreme cases sloughing and hæmorrhage into the conjunctiva may take place. Affection of the cornea is a not unusual complication, in which case it nearly always ends in total destruction of the sight. Fortunately, since the introduction of the antitoxin, these bad results are not so often met with.

Treatment.—Directly the diagnosis is made from the smear preparation, and also in all cases of doubt, the patient should be isolated, and antitoxin should be administered under the skin of the back or abdomen. The eyes should be thoroughly cleaned with perchloride lotion, 1–6,000, and all the membrane wiped away as far as possible. In cases where antitoxin is not available nitrate of silver applied locally is of use. If only one eye be affected every precaution should be taken against infection of the other by covering it with a Buller's shield, and by taking care that in washing out the eye the lotion does not run over to the unaffected side.

Staphylococcal Conjunctivitis varies much in severity, just as the virulence of the staphylococcus itself varies. Staphylococcus aureus usually produces a severe attack of purulent conjunctivitis, whilst the staphylococcus albus produces a very mild form. Its main characteristic is that unless treated it is apt to become chronic, especially when associated with the Morax-Axenfeld bacillus.

Streptococcal Conjunctivitis produces a most severe form of membranous conjunctivitis, frequently associated with destruction of the cornea (keratomalacia).

Pneumococcal Conjunctivitis is usually of moderate severity, and is the only form of conjunctivitis which may give rise to iritis without invasion of the cornea. This is supposed to be due to the action of its toxins.

Other organisms which are occasionally found as the cause of purulent conjunctivitis are the bacillus coli communis, the diplococcus intracellularis meningitidis, micrococcus lutens, Friedländer's pneumo-bacillus, diplobacillus of Petit, and bacillus of Zur Nedden, but these are too rare to describe here.

2. CHRONIC CONJUNCTIVITIS may be—

(*a*) Simple.
(*b*) Trachoma.
(*c*) Parinaud's conjunctivitis.
(*d*) Spring catarrh.
(*e*) Tubercular.
(*f*) Syphilitic.
(*g*) Vaccinial.

(*a*) **Simple Chronic Conjunctivitis** may be due to (1) An acute attack which has been imperfectly or insufficiently treated, and is frequently associated with blepharitis ; especially is this the case when the infection is due to the Morax-Axenfeld bacillus, or the staphylococcus albus which are often present together. The untreated discharge from the eyes in measles is another common cause.

2. General injuries, influenza, constant exposure to cold (e.g. in coachmen), overcrowding and a bad atmosphere (e.g. in Jew emigrants).

3. Local injuries, associated with purulent dacryocystitis, inflammation of the Meibomian glands, entropion, etc.

4. An error of refraction, causing hyperæmia, as a result of eye strain.

Symptoms.—The subjective symptoms are often the most marked feature of this disease in mild cases. The patient complains of a gritty, dry, itching or burning feeling in the eyes or of heaviness of the lids, usually worse towards the end of the day, or of a feeling of some foreign body in the eye, due to mucus floating about in the conjunctival sac. The objective symptoms are frequently slight, there being little or no discharge, except perhaps the first thing in the morning. White, beaten up Meibomian secretion, from constant blinking, is often found at the angle of the eyelids. In the more severe cases in children, discharge can be found adherent to the lashes, styes are frequent, and the lashes fall out as the result of infection of the hair follicles. The conjunctiva in early cases is smooth and hyperæmic ; after a time it becomes papillated, a very frequent appearance amongst Jews. In children follicles are frequently present in the lower fornix, and even in the upper fornix, especially at the ends of the tarsal plates. Epithelial cysts, as the result of blocking of the mouths of the new formed glands, are not infrequent.

Complications.—*Ectropion* and eversion of the lower punctum is liable to occur, especially in old people with lax lids, owing to the constant wiping away of the discharge, and in children with blepharitis from the swelling and cicatrization of the lid margins.

Phlyctenulæ frequently accompany the disease from infection of the deeper layers of the conjunctiva, and *Corneal ulceration* from infection of the cornea.

Treatment.—The first thing to do is to remove the exciting cause. Healthy surroundings—correction of refraction errors—protection with glasses from wind in cases due to exposure. Frequent cleansing of the eye with boric lotion, or in the case of Morax infection, with zinc lotion ; when the eyelid margins are affected, ung. hydg. nit. dil. or ung. hydg. ox. flav. dil. should be smeared on them. The treatment should be continued for some months.

(*b*) **Trachoma** is a contagious disease carried by the secretion from one eye to another. It is characterized by the formation of follicles and infiltration of the conjunctiva, which goes on to subsequent cicatrization and partial obliteration of the conjunctival sac (Fig. 30).

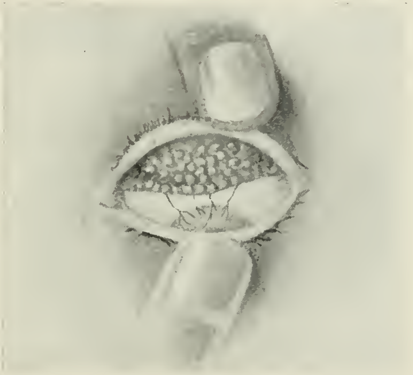


Fig. 30.—Trachoma with Pannus.

Ætiology.—Being contagious, it is found principally amongst large bodies of people, as in schools, armies, etc. It is particularly prevalent among the Jews, especially of the emigrant class. It also varies in geographical distribution, being very prevalent in Egypt and Arabia, but absent in high parts of Switzerland. The disease as it is found in England is by no means so severe as the type found amongst the Polish Jews and in Egypt.

Symptoms.—The patient's attention is usually drawn to it either by a slight discharge, photophobia, or drooping of the lid, the subjective symptoms in the early stages often being very slight. Later on, some defect of vision is noticed, caused by the development of pannus.

Clinically, the disease usually appears at first in the upper fornix, and is characterized by the formation of follicles. These follicles may remain for a long time, and reach a large size without giving rise to symptoms. At other times a muco-purulent discharge is set up. This discharge does not occur in all cases, or at the same period of any particular case, and indeed may not occur at all. Pyogenic organisms are always found in the secretion, and indeed the purulent discharge in these cases may be looked upon as a result of septic infection of the conjunctiva as well as of trachoma, which doubtless lowers the vitality of the tissue. This muco-purulent conjunctivitis may produce various results in the disease. It may be associated with increased extension of the disease, as is seen in the most virulent cases, which are often accompanied by a great quantity of discharge ; or it may bring about its cure, since cases of trachoma which have been infected with gonorrhœal ophthalmia have cleared up as the latter disease subsides.

Pathology.—No specific micro-organism has yet been identified with the disease, although the balance of evidence is in favour of such a cause being present. Whatever the cause may be, the essential change is necrosis, both in the follicles and in the infiltrated area of the conjunctiva ; this leads to subsequent scarring, which is the most characteristic feature of the disease. In the early stages, papillary hypertrophy is often very marked, masking the follicles (*papillary trachoma*) (Fig. 31). When the follicles are well developed it is known as *follicular trachoma.* When cicatrization is taking place, and the infiltration is undergoing hyaline change, a brawny condition is produced (Stelwag's brawny œdema).

The constant contact of the follicles present in the upper lid with the limbus and upper part of the cornea leads to their infection as the result of this infiltration, and follicular formation takes place at the limbus and subsequently spreads to the superficial layers of the cornea, which become

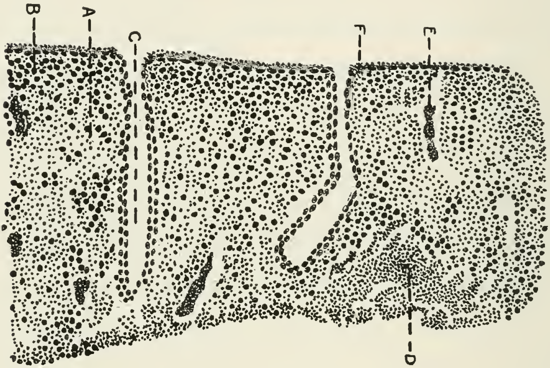


Fig. 31.—Papillary formation in early Trachoma.

A. Papilla.
B. Plasma cells.
C. Crypt.
D. Portion of a trachomatous lymph follicle.
E. Blood vessel.
F. Epithelium.

hazy and vascular (*pannus*). Small grey ulcers may appear from time to time, until the whole cornea may be affected with the disease. Under treatment, this often clears considerably, but almost always leaves some opacity (Figs. 30, 32 and 43).

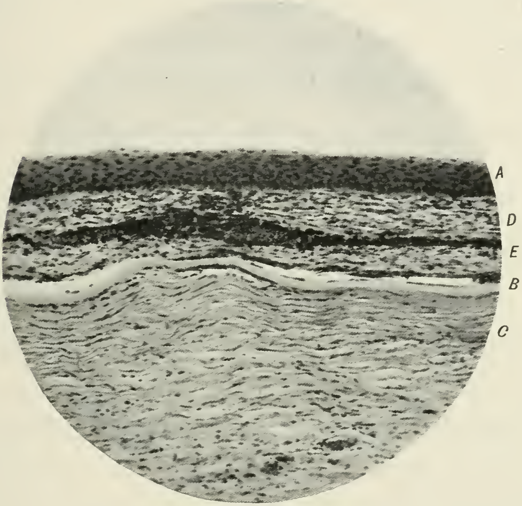


Fig. 32.—Trachomatous Pannus.

A. Epithelium.
B. Bowman's membrane.
C. Substantia propia.
D. Cellular infiltration and fibrous tissue forming the pannus.
E. Blood vessel.
After a time Bowman's membrane becomes destroyed.

When the disease has reached its height, and cicatrization takes place, it leads to—

1. Obliteration of the conjunctival fornices.

2. Formation of bands and cicatrices, one of which is always found in the sulcus subtarsalis as a white line—a point often of great diagnostic value.

3. Contraction which may give rise to buckling of the tarsal plate with trichiasis (in-growing lashes) or entropion (turning in of the whole lid).

4. Epithelial cysts, from obliteration of the mouths of the new formed glands.

5. Secondary xerosis, which is due to keratinization of the epithelium, secondary to drying from the absence of secretion.

Diagnosis.—In the stage of early follicular formation, the diagnosis from other causes of follicular enlargement is often difficult and even impossible, unless the patient is kept under careful observation. The following are the principal distinguishing features :—

Clinically.—(1) The follicles in follicular conjunctivitis are found principally in the lower fornix, whilst those of trachoma are in the upper. Follicles occur on the tarsus in trachoma.

(2) Scarring is absent in follicular conjunctivitis.

(3) Pannus is absent in follicular conjunctivitis.

(4) It has been said that trachoma is most common in adults, although there is considerable doubt about this statement ; whereas follicular conjunctivitis occurs principally in children.

Microscopically.—(1) By the increased new mucous gland-formation in the epithelium.

(2) By the presence of necrosis of the plasma cells in the follicles and the increase of fibrous tissue.

(For the differential diagnosis of pannus *see* p. 127).

Treatment.—Since there is no specific cure for this disease, the aim is to eradicate it as far as possible with the least destruction to the conjunctiva by—

1. Operative measures. 2. Phagocytosis.

1. *Operative measures.*

Expression.—There can be no doubt that this form of treatment is most satisfactory in the case of follicular enlargements. Unfortunately we have no means at the present time of distinguishing between infected and uninfected follicles. It acts, probably, first by getting rid of the central foci of the disease in the follicles; and, secondly, by the cavities from which they are evacuated becoming septic, the mechanical irritation producing an increased polynuclear phagocytosis into the tissues.

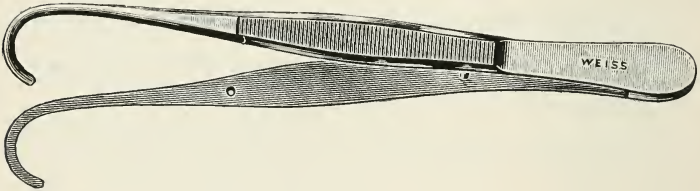


FIG. 33.—Graddy's forceps.

The operation may be performed under cocaine and adrenalin, a little solid cocaine being rubbed into the area to be expressed. In severe cases, in which both eyes are affected, and in small children, a general anæsthetic may be necessary.

Although a number of instruments are in use, perhaps the best, and certainly the least painful, is Graddy's forceps (Fig. 33). In the case of the upper lid, it is first everted, one blade of the forceps being passed into the fornix, the other being placed over the upper surface of the everted lid. A gentle steady pressure is applied, and the lid drawn out between the blades. In this way as much of the conjunctiva is gone over as is necessary. The lower fornix is best expressed by picking up the loose fold with ordinary forceps and then expressing by Graddy's.

If only one or two follicles be present they can be picked up with ordinary fine dissecting forceps and expressed. But when situated on the tarsus the follicles are best enucleated by a spud. A little orthoform subsequently rubbed over the palpebra conjunctiva relieves the pain experienced by the patient when the effect of the cocaine has worn off. Afterwards the lids may be treated by one of the various methods to be described later.

2. *Phagocytosis.*

(*a*) *Chemical.—Solid copper sulphate* is perhaps most frequently used for this purpose, as with it a certain amount of friction can be applied, and it stains the conjunctiva less than other caustics. It is best used in the form of a smooth pencil, the points which show most changes being especially picked out. It should be applied daily in the more severe cases. The pain attending its use generally lasts from three to four hours, and may be alleviated by using cocaine at the time, adding orthoform to the copper stick, and bathing the eyelids directly afterwards with iced water.

Fluid.—Corrosive sublimate, 1–50, in glycerine and water, applied by rubbing into the lids with a wool mop, is perhaps not so satisfactory as the former drug, but is useful after expression.

Silver nitrate has the great drawback that, after prolonged use, the silver is reduced and stains the conjunctiva (argyrosis). This drug is especially valuable when there is much discharge, and in cases where injection of the lids remains after the disappearance of the follicles.

(*b*) *Jequirity* was first used in Brazil. It was prepared as an infusion from the seeds of the *Abrus precatorius.* Its action, as de Wecker pointed out, is due to the presence of an unorganized ferment which belongs to much the same order as the snake poisons. When inoculated into the conjunctival sac it produces a muco-purulent conjunctivitis of a somewhat varying severity, which cannot be regulated, and is therefore dangerous.

Lately the toxin has been isolated from the ferment and is called Jequirol ; this toxin is standardized in three separate strengths, and produces a similar reaction to that caused by the ferment when applied to the conjunctival sac, but one which can be regulated to a certain extent. It is usually applied by painting over the surface of the lids two or three times in half an hour, and then waiting for the reaction to take place. It is especially useful in pannus, and its effect, if too severe, can be stopped by the use of the antitoxin.

(*c*) *Ultra-violet radiation.*—Exposure to X rays three times a week for five minutes (8 amp. 3 inch spark gap) is extremely useful, especially where there is a large amount of pannus; this must be applied to the everted lids. The treatment has the advantage of being painless, and is best alternated with the use of copper sulphate. Cures have also been reported from the use of radium and high frequency currents.

(*c*) **Parinaud's Conjunctivitis** is a comparativly rare disease characterized by a subacute inflammation of the conjunctiva accompanied by a discharge and marked follicular formation in both upper and lower fornices which at first sight resembles a virulent trachoma, but is associated with enlargement of the preauricular and submaxillary glands. It usually affects only one eye. The disease subsides in about six weeks, corneal complications being rare.

The cause is not known, but a history of animal infection is not uncommon. Staphylococci are very frequently found in the discharge.

Treatment.—Consists in cleansing the eye with boric lotion—nitrate of silver in the early stages is useful in decreasing the discharge.

(*d*) **Spring Catarrh**—a rare condition—is unlike that which occurs in the nose. It is a chronic disease with exacerbation in the spring and summer.

Symptoms.—During the winter the patients are free from any discomfort, but in the spring their eyes become irritable and itching, with photophobia and lachrymation, which begin to disappear in the autumn. On examination the upper tarsal conjunctiva is injected, and covered with large papillæ with flat tops which are covered with a bluish white film of secretion (Fig. 34). The papillæ are composed of fibrous tissue and contain large numbers

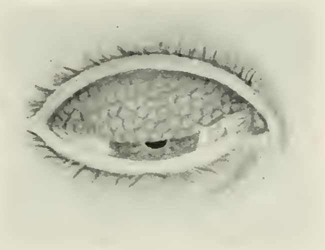


Fig. 34.—Spring Catarrh.

of eosinophiles (Fig. 35). Similarly the secretion consists almost entirely of these cells—a point which renders the diagnosis easy from trachoma by making a smear preparation and staining with Leishman's stain (Fig. 36). The limbus is affected in some cases by raised semi-translucent masses.

Treatment consists in the amelioration of symptoms. Locally constant bathing with boric lotion, and the use of adrenalin drops during the acute stages.

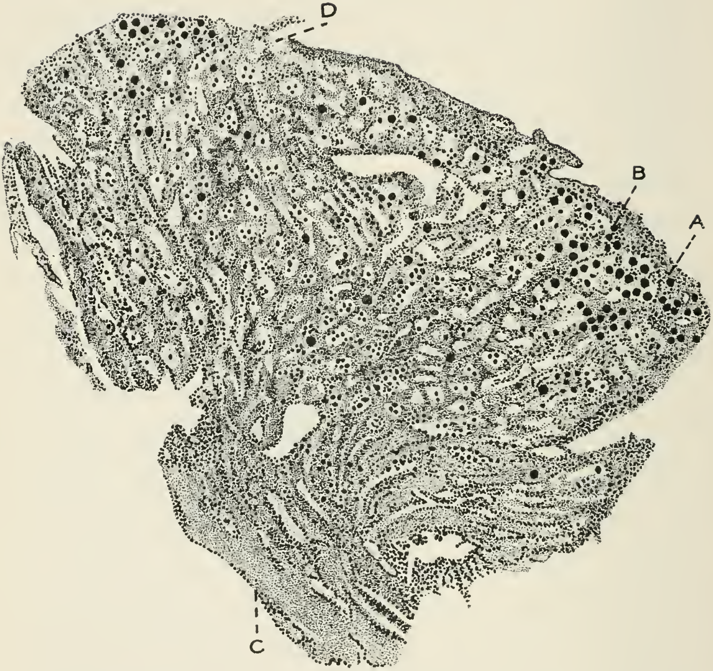


Fig. 35.—Section of one of the papillæ from a case of vernal catarrh.

A. Epithelium.
B. Eosinophiles.
D. Erosions of the epithelium.
C. Fibrous tissue.

The removal of the papillæ, if large, is often useful in allaying symptoms, but they are apt to recur. General constitutional treatment with iron and arsenic is often useful.

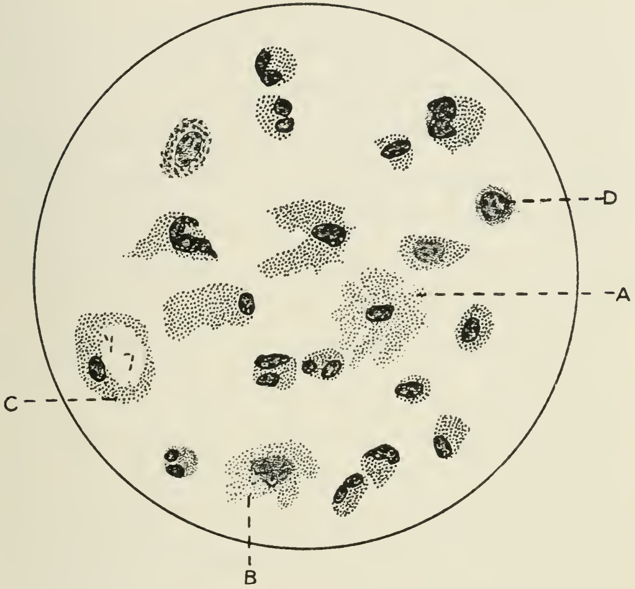


FIG. 36.—Discharge from a case of vernal catarrh showing eosinophiles.

A, B, C. Eosinophiles.
D. Lymphocytes.

(*e*) **Tubercle** of the conjunctiva is very rare as a primary condition, but occurs more frequently as a secondary infection to lupus of the face, nose or lachrymal sac.

Symptoms.—Clinically it may assume several different appearances, the chief of which are—

1. *Follicles* which form and caseate, with the production of small ulcers. These cases are usually primary in the conjunctiva.

2. *Cockscomb Excrescences*, which usually spring from the fornices and may become pedunculated. They form the most frequent appearances of tubercle in the conjunctiva and are often secondary to disease of the lachrymal sac.

3. *Large ulcers* with prominent granulations are seen in advanced stages of the disease.

Enlargement of the preauricular gland is common.

Diagnosis is usually easy from the associated condition (lupus of face, lachrymal sac, etc.). The cockscomb excrescences are most liable to be mistaken for sarcoma, but can be distinguished microscopically by removal of a portion, and by inoculation in doubtful cases.

Treatment.—Is to remove as much of the diseased areas as possible by forceps and scissors. Cauterizing, scraping, and rubbing with iodoform, are useful for advanced cases. The general treatment of tuberculous patients and the administration of tuberculin controlled by the opsonic index should be carried out. The prognosis to the conjunctiva is on the whole good, provided the disease is not far advanced.

(*f*) **Syphilis** of the conjunctiva is a rare disease. Primary chancres occur as the result of inoculation; not infrequently as the result of removal of foreign bodies with the tongue—a practice common amongst the lower classes.

Diagnosis.—The conditions for which it are most liable to be mistaken are sarcoma or vaccinia. The diagnosis is usually easy by the rapid onset and extensive enlargement of the glands, secondary rash and throat. Failing this a microscopic examination of the tissues or the finding of the spirochaete pallida in scrapings from the ulcerated surface will help.

Secondary and tertiary syphilis usually take the form of ulcers about the conjunctiva, but are very rare.

Treatment.—*Local.* Lot. Hyg. perchlor. and calomel dusted on the lesion. General treatment should also be administered.

(*g*) **Vaccinia.**—The source of infection is usually from the arm of a baby, or rarely, in the case of medical men, a broken vaccine tube. The whole conjunctiva becomes intensely œdematous, a pustule forming usually about the lid margins. The preauricular gland is enlarged. The treatment consists of keeping the eye clean with boric lotion. The cornea is rarely affected.

Phlyctenula.—Although this name (meaning "a little bladder") is not, strictly speaking, accurate, since the exudation, at any rate at first, consists of cells, it seems to be rather better than some other names, such as conjunctivitis eczematosa, or herpes conjunctivae, which are incorrect as to their pathological significance and give a wrong impression.

Clinically, in its simplest form, a phlyctenule is a small red eminence, about the size of a millet seed, usually seen in the ocular conjunctiva in the region of the limbus, with a leash of dilated vessels leading up to it (Fig. 37). As a rule the epithelium on the surface of the eminence gives way, with the extrusion of the contents and the formation of a greyish looking ulcer which rapidly heals. Occasionally these nodules disappear without the formation of an ulcer. Almost invariably the disease is preceded by some other form of conjunctivitis, it being very rare to find a case in which there has not been some slight discharge beforehand, if the history be carefully inquired into.

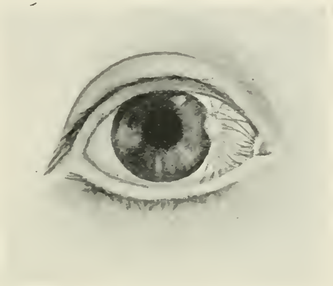


FIG. 37.—A Phlyctenule.

The *position* of the phlyctenule is by no means limited to the limbus, although it is certainly the commonest situation for the lesion. It is found in other parts of the bulbar conjunctiva and more rarely on the palpebral conjunctiva.

Finally, phlyctenules may start in or spread to the cornea from the limbus, and, when lasting for some time, become vascularized by the budding out of the endothelium of the vessels from that region.

The *number* of phlyctenules varies considerably. In some cases there are only one or two, in others they may be extremely numerous, the conjunctiva in the neighbourhood of the limbus being covered with very small nodules which do not usually break down into ulcers, but resolve. In cases in which the discharge from the eye runs down over the face a number of pustules are formed in the skin from direct infection.

The patients are usually children, although not invariably so, and are as a rule run down in health. It is stated that these cases are always tuberculous, and it is supposed by some authorities that the lesions are of a tubercular nature, but since the surroundings which give rise to both diseases are the same, this theory is of but little value, especially as it is not supported by the pathological evidence. Phlyctenules are apt to recur until health is re-established.

Pathology.—Histology shows that phlyctenules are minute abscesses in the deep layers of the conjunctiva which rupture through the surface with the formation of an ulcer (Figs. 38-39). The most common organisms associated with this disease are the Koch-Weeks' bacillus and staphylococcus. Some of the cases in which big ulcers form are

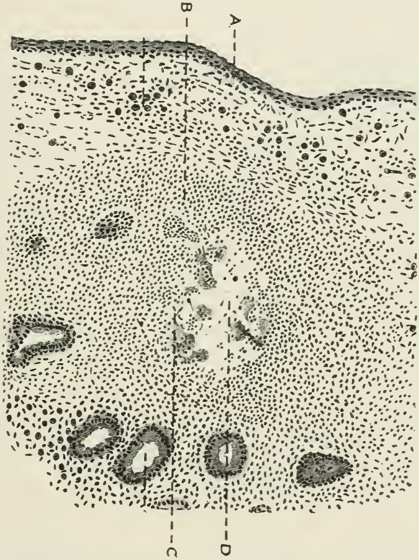


Fig. 38. Phlyctenule from the lid. Early stage, before rupture.
A. Epithelium.
B and *C.* Cellular exudation.
D. Cavity containing pus.

probably of a tuberculous nature, although the actual proof is still wanting. Occasionally a phlyctenule may resolve without rupture.

Treatment.—Locally, the eye must be kept clean by mild antiseptics, 1-6,000 hydrarg. perchlor. or Lot. boric. Protargol 10 per cent. as drops, may be used locally to decrease the discharge. If the cornea is involved atropine should be substituted for the protargol.

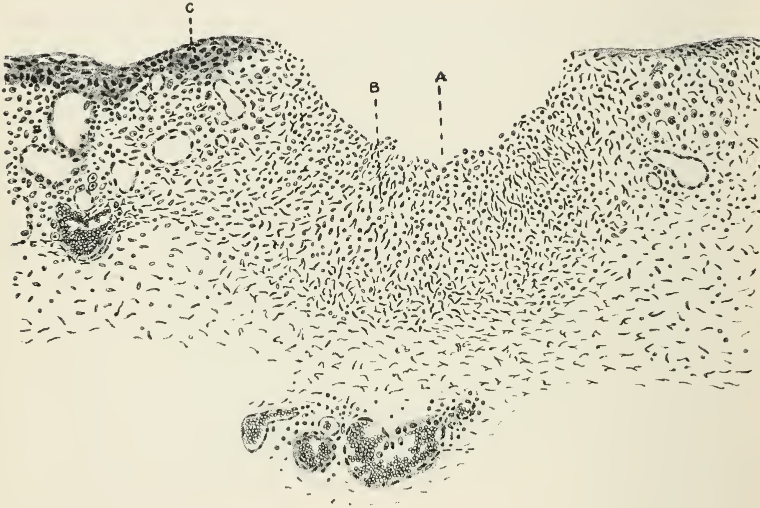


FIG. 39.—Phlyctenule after rupture.

A. Base of the ulcer.
B. Cellular exudation.
C. Epithelium.

General tonic treatment must also be administered.

Pemphigus is a rare disease of the conjunctiva. It may occur with or without the skin lesion. The patient is usually very ill during its onset. There is intense photophobia and pain with the eruption of the vesicles, leading finally to much scarring and formation of bands in the conjunctiva, with secondary xerosis. Cysts are a very frequent result.

Treatment.—Atropine and bathing in the early stages locally, with arsenic internally. Vaseline should be used in the later stages, to prevent xerosis.

A **Pinguecula** is a small mass of hypertrophied yellow elastic tissue seen at the limbus, in the palpebral aperture usually, in eyes subject to much exposure. It can be removed if causing annoyance from its appearance.

A **Pterygium** is a triangular fold of conjunctiva in the same situation as a pinguecula but involving the cornea (Fig. 40). It is usually described as having a head adherent to the cornea, a neck at the limbus, and a body passing into the conjunctiva ; it is red and vascular and may spread across the cornea and so affect the sight. It occurs principally in old people and those liable to exposure. Around the head a grey area of degenerating cornea is seen. It is probably due to a degeneration in the corneal epithelium, which is replaced by the conjunctiva. If spreading it had better be removed. The base is divided and is carefully dissected up to the cornea, from which it is then torn off. The wound must be carefully sewn together, or it will recur.

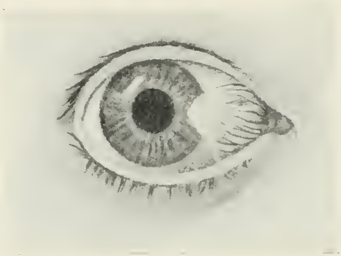


FIG. 40.—Pterygium.

Symblepharon is the adherence of the lid to the globe. It is generally the result of burns, operation or ulcers. Obliteration of the fornices, as in trachoma, is known as symblepharon posterior, for which little can be done. Adhesion of the lid near the margin to the globe is known as symblepharon anterior. The condition, when due to injuries, can often be alleviated by some form of plastic operation with or without grafting of mucous membrane.

Xerosis is essentially a drying of the conjunctiva with keratinization of the epithelium and adherence to it of Meibomian secretion which contains the so-called xerosis bacilli (pseudo-diphtheritic bacillus) which is a saphrophyte growing in the Meibomian secretion, and has no relation to the disease (Fig. 41).

It is divided into—

1. Primary. 2. Secondary.

1. **Primary Xerosis** may either affect the bulbar conjunctiva in the palpebral aperture, or the whole conjunctiva; in the latter condition it is often associated with kerato-malacia. The disease is always associated with defective health, and is especially prevalent in the spring during the hot dry winds. Night blindness is frequently complained of, and this, together with the deficient lachrymal secretion, possesses a common cause, namely, malnutrition. The disease is practically limited to children and sailors.

2. **Secondary** xerosis following on pemphigus and the cicatrization stage of trachoma is principally limited to the scar tissue.

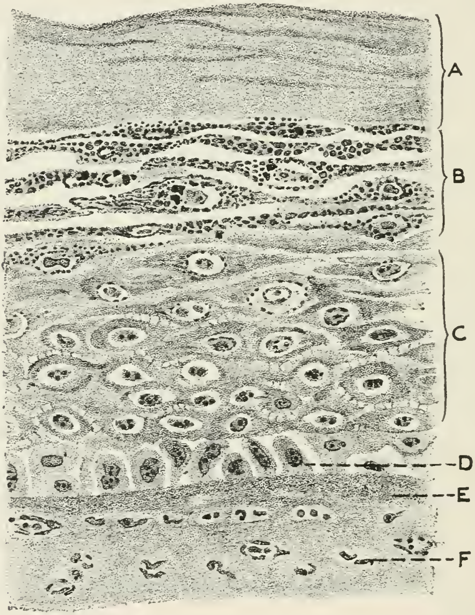


FIG. 41.—Xerosis of the Conjunctiva.

A. Keratinized layer.
B. Layer of cells with keratohyaline granules.
C. Prickle cells.
D. Basement cell layer.
E. Basement membrane.
F. Subepithelial tissue.

Treatment.—In the primary cases this consists in improving the health of the child, plenty of green vegetables being desirable. Locally the use of oil prevents the formation of the patches and renders the cornea less liable to infection.

Cysts of the Conjunctiva.—1. Epithelial. 2. Serous.

1. **Epithelial.**—*Retention* from newly formed glands or from existing glands (Krause, Waldeyer).

Traumatic.—Implantation dermoids due to an inclusion of epithelium following injury.

2. **Serous.**—*Lymphangiectasis* usually occurs in the bulbar conjunctiva as a string of clear vessels.

Parasitic.—Cysticercus and filaria have been known to occur.

Treatment.—They can be excised if causing trouble. Small epithelial cysts, the contents of which are often calcified, are best opened and the contents evacuated. Lymphangiectases are best treated by massage with ung. hyd. ox. flav. dil. and if no improvement takes place they can be excised.

Tumours of the Conjunctiva are—1. Simple. 2. Malignant.

1. Simple.—**Dermoid** patches and dermo-lipomata with hair growing from the surface occur, especi-

ally on the outer side of the bulbar conjunctiva, and are probably due to imperfect closure of the eyelids during development allowing the conjunctiva to develop like the skin.

Moles.—There is normally some pigmentation around the limbus, which is much increased in dark people. Pigmented naevi are not uncommon and when small they may at first sight be mistaken for a foreign body. Occasionally the whole conjunctiva may be affected.

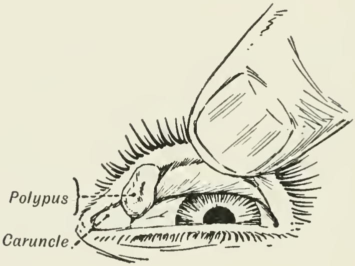


FIG. 42.—Polypus of the Conjunctiva.

Polypi (Fig. 42) arise in two ways—

1. By the nipping of a portion of the fornix between the lid and the globe.

2. By a granulation, such as after a tenotomy or

a ruptured Meibomian cyst becoming covered with epithelium.

Papillomata occur principally on the plica semilunaris and caruncle. They form raspberry like tumours, and are composed of multiple leaflets of epithelium, somewhat resembling the papillomata which occur in the bladder.

Hæmangioma and **Lymphangioma** do occur, but are very rare.

Treatment.—Dermoids, polypi and papillomata are best removed by a free incision, taking care to excise the base of the tumour and stitching the conjunctiva together over the wound. A fine pair of straight forceps and sharp pointed scissors are the most satisfactory instruments to use.

Lymphangioma and hæmangioma if small can be removed entirely ; if large, portions of them can be removed ; the latter operation is liable to be followed by severe hæmorrhage.

2. Malignant. (*a*) Carcinoma. (*b*) Sarcoma.

1. **Epitheliomata.**—The site of election is the limbus, where the conjunctival epithelium changes to that of the cornea. They tend to form warty lens

shaped growths, which very slowly involve the cornea. The glands (preauricular and submaxillary) are usually late in becoming affected.

Treatment.—If small they can be removed locally, the base being cauterised. But if of any size the whole globe had better be excised with the conjunctiva surrounding the growth. The prognosis is good provided the glands are not affected.

2. **Rodent Ulcer** involving the conjunctiva is usually secondary to that in the same eyelid and a cure can be brought about either by X rays or radium, provided the bone is not affected. In the latter case very extensive evisceration of the orbit may be necessary.

Sarcoma.—1. *Melanotic* may start in the pigment cells at the limbus, or from a pigmented mole. They form rapidly growing, pigmented tumours with early secondary glandular enlargement.

2. *Lympho-sarcoma* may start in any part of the conjunctiva, most commonly in the fornix. It forms a diffused pink mass with early glandular enlargement. The diagnosis from tubercle and primary chancre is often difficult without microscopical examination.

Treatment is free excision, which usually means evisceration of the orbit. Occasionally early melanotic growths can be removed locally. The prognosis is bad, owing to frequent secondary recurrences, unless the growth is very small.

CHAPTER IV

DISEASES OF THE CORNEA AND SCLEROTIC

The cornea forms the anterior part of the fibrous envelope of the eye, and in its normal state is transparent. It has a greater curve than that of the sclerotic, into which it is set like a watch glass; that is to say, the cornea is overlapped by the sclerotic on its anterior surface. It is thinner in the centre than at the periphery, and measures vertically 11 mm., horizontally 12 mm., and in its greatest thickness 1 mm. It is formed of the following layers from without inwards: (1) squamous epithelium; (2) Bowman's membrane, which is an elastic tissue membrane intimately connected with (3) the substantia propria, which is made up of laminated bundles of connective tissue, containing cells (corneal corpuscles). Beneath this is (4) Descemet's membrane, which is composed of elastic tissue, and is covered posteriorly by (5) a single layer of endothelial cells, from which Descemet's membrane is formed during development. Embryologically the epithelium corresponds to the conjunctiva, the substantia propria to the sclerotic, and Descemet's membrane to the uvea—points which often become manifest in studying the diseases of this part of the eye.

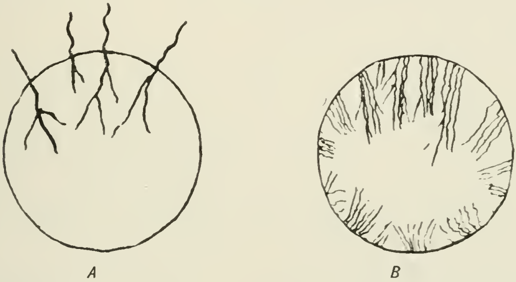


FIG. 43.—Showing the types of new vessels in trachoma and interstitial keratitis.

A. Trachoma—large branched vessels derived from the conjunctival vessels.
B. Interstitial keratitis—fine unbranched vessels derived from the ciliary circulation.

The cornea normally contains no blood vessels, but is nourished from lymph derived from the conjunctival and ciliary vessels at the margin. Similarly cells may wander into the cornea through the lymph spaces. New blood vessels may form in the substance of the cornea as a result of inflammation, these, if superficial, as in pannus, are derived from the conjunctival vessels; but if deep, as in interstitial keratitis, come from the ciliary vascular system. It is often of great importance, in making a diagnosis of the original cause of an opacity, to recognize the difference between the two sets of vessels (Fig. 43).

They are—

Superficial.	Deep.
1. Large in size.	1. Very fine hairlike vessels.
2. Bright red in colour.	2. Colour often not very distinguishable.
3. Arborescent.	3. Running parallel with each other.
4. The corneal surface is wavy over them.	4. The corneal surface is smooth, although it may be opaque.
5. Vessels can be traced from the conjunctival vessels.	5. Vessels are lost at the corneal margin, since they are derived from the ciliary vessels.

In making an examination of the cornea the following points must be noted:—

1. *The size and form.* By focal illumination.

2. *Curve*	By placoscopic disc, retinoscopy mirror, and astigmometer.
3. *Evenness* . . .	By even reflex of light from the surface.
4. *Polish*	By its bright appearance.
5. *Transparency* .	By focal illumination, or the small ophthalmoscopic mirror with + 20 D behind.
6. *Sensitiveness* . .	By touching the surface with a fragment of wool.

Injuries.—**Foreign bodies** are best removed by a spud or sharp aseptic needle after instilling cocaine. In cases where they have penetrated to some depth the needle is inserted a little way from the foreign body, which is then lifted out through the entrance wound. The eye should be cleansed and subsequently tied up for a few hours. If there are any signs of inflammation atropine should be instilled.

Wounds may be penetrating or non-penetrating, the former are followed by an escape of aqueous humour. The edges usually approximate of themselves, swell up and, if aseptic, heal rapidly, the aqueous humour reforming in from a half-hour to several days. Delay in healing may be brought about by—

1. Want of rest.

2. Incarceration of the iris or ciliary body in the wound (cystoid cicatrix). This condition is dangerous in that the iris, lying so near the surface, may become infected from the conjunctiva, giving rise to an irido-cyclitis, which may cause sympathetic inflammation (irido-cyclitis) in the other eye.

3. Incarceration of the lens, vitreous, retina or lens capsule in the wound, giving rise to complications.

4. The formation of a fistula by the down-growth of the epithelium covering the margin of the wound which prevents union. Occasionally the whole anterior chamber may be found lined with epithelium.

5. The carrying in of foreign bodies, cilia, etc.

Treatment.—Wounds should be cleansed by 1 in 2,000 hydrarg. perchlor. lotions, followed by boracic. If the wound be very extensive, especially if it involves the ciliary body or lens, or if septic, enucleation may be advisable. If there is a possibility of saving the eye, atropine should be instilled to prevent incarceration of the iris. If the iris is prolapsed it should be drawn out of the wound as far as possible and cut off close to the surface of the cornea, the angles being returned with a spatula. The eye must be tied up and the patient kept in bed if the wound is at all severe.

Blood staining of the cornea due to the forcing of blood between the fibres of the substantia propria is of importance in that at first sight it may be mistaken for a lens dislocated into the anterior chamber.

Inflammation.—Keratitis.

Inflammation of the cornea may be divided into two types—

1. SUPPURATIVE.
   - (*a*) Phlyctenular ulcers.
   - (*b*) Serpiginous ulcers.
   - (*c*) Kerato-malacia.
   - (*d*) Neuro-paralytic ulcers.
   - (*e*) Onyx (abscess of cornea)

2. NON-SUPPURATIVE.
   - (*a*) *Superficial.*
     1. Vesicular: Bullous, dendritic, herpes zoster, superficial keratitis punctata.
     2. Pannus
     3. Mooren's ulcer.
   - (*b*) *Deep.*
     1. Interstitial keratitis.
     2. Keratitis associated with tubercle of the iris.
     3. Sclerosing keratitis.
     4. Striate keratitis.

1. Suppurative. **Ætiology and Pathology.**—The different varieties of suppurative inflammation of the cornea differ from each other in (1) *The nature of the infection.* By far the most common organism found in so-called serpiginous ulcers is the pneumococcus, especially when it is associated with lachrymal obstruction. There is usually some history of injury. Streptococci are commonly met with in kerato-malacia, whilst the bacillus Morax-Axenfeld and staphylococcus are associated with small grey ulcers formed near the corneal margin. The staphylococcus is also found in the phlyctenular type of ulceration.[1]

(2) *The condition of the cornea.* In the case of neuro-paralytic ulcer the cornea is anæsthetic, and therefore, more liable to injury, and at the same time, having lost its trophic nerve supply its nutrition may be seriously affected. In cases in which the cornea is imperfectly covered by the eyelids (ectropion paralysis of seventh nerve) infec-

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[1] The gonococcus and Klebs-Loeffler bacillus are frequent causes of severe corneal ulceration secondary to conjunctival infection.

tion is more liable to take place owing to exposure.

(3) *The general condition of the patient.* In kerato-malacia, which always occurs in marasmic infants, who have no resisting power to the streptococcus, the ulceration runs an extremely rapid course. Very frequently the patient has xerosis, which also predisposes to infection by the absence of the mechanically cleansing effect of the lachrymal secretion.

In phlyctenular ulcer, the condition, although due to infection, is kept up by the low nutrition of the patient, and the ulcer will often fail to heal until the general health is improved.

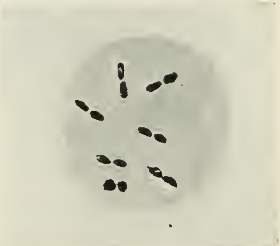


FIG. 44. — Pneumococci from a serpiginous corneal ulcer following lachrymal obstruction.

Clinical Signs.—(*a*) *Phlyctenular ulcers* are small, usually situated about the limbus, spreading inwards from that position, and carrying with them a leash of vessels. Other phlyctenules are often present in the conjunctiva.

(*b*) *A serpiginous ulcer* forms a grey or yellowish disc with much infiltrated margins, the cornea surrounding it having a ground glass appearance. There is usually a purulent discharge from the eye. Frequently it is associated with an acute iritis and there may be a quantity of pus lying at the bottom of the anterior chamber (hypopyon) (Fig. 56, p. 177). Subsequently the ulcer may invade the whole cornea and perforate, allowing the hypopyon and aqueous to escape, when one of the complications mentioned below usually follows.

(*c*) In *kerato-malacia* the whole cornea melts away with great rapidity—often in a few hours.

(*d*) *Neuro-paralytic ulcers* usually resemble serpiginous ulcers, except that the cornea is anæsthetic, and hence there is an absence of photophobia, which is so marked in other cases. The prognosis of this type of ulcer is very bad, as there is little tendency to resolution.

(*e*) *Onyx* (abscess of the cornea) is frequently due to some injury. There is a purulent mass in the corneal substance which may subsequently break through the surface and form a serpiginous ulcer, or more rarely, perforate into the anterior chamber. The condition is most commonly seen in children.

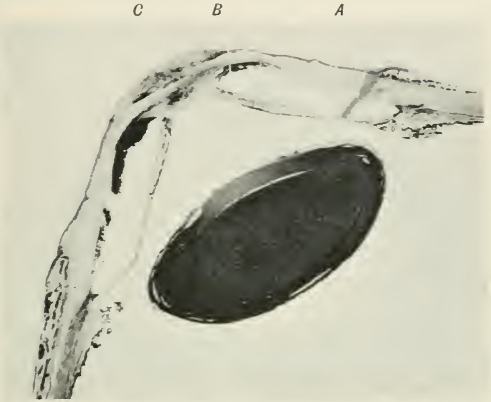


Fig. 45.—Anterior Synechiæ following a perforating corneal ulcer.

A. Cornea.
B. Iris adherent to the base of the old ulcer.
C. Leucoma.

Complications.—If the infection is very acute the whole eye may suppurate (*panophthalmitis*).

Perforation may ensue with *incarceration of the iris* in the base of the ulcer which, when healing takes place, is known as a *leucoma adherens* (Fig. 45).

If the lens is in contact with the base of the ulcer an opacity forms where it lies in contact (*anterior polar cataract*) (Fig. 47).

Where perforation is not complete and Descemet's membrane bulges into the wound it is known as a *keratocele.*

The opacity left by an ulcer depends on the amount of substantia propria which is destroyed, if the opacity is not dense, it is known as a *nebula* ; if dense, as a *leucoma* (Fig. 45, *C*).

If the whole corneal cicatrix bulges subsequently it is known as an *anterior staphyloma* (Figs. 46, 47).

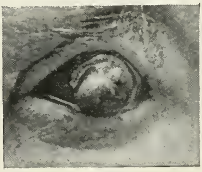


Fig. 46.—Anterior staphyloma following corneal ulceration.

Treatment.—1. Remove the cause, such as foreign bodies, or an eyelash rubbing the cornea.

2. If possible determine the organism in the discharge, as in some cases due to pneumococcus and staphylococcus the cases have been successfully treated by serum and vaccines.

3. Keep the eye cleansed by hot boric or hydg.

perchlor. (1 in 6,000) lotion every hour, and in severe cases hot fomentations should be applied. Atropine, 4 grs. to the oz., must be instilled every four hours to dilate the pupil.

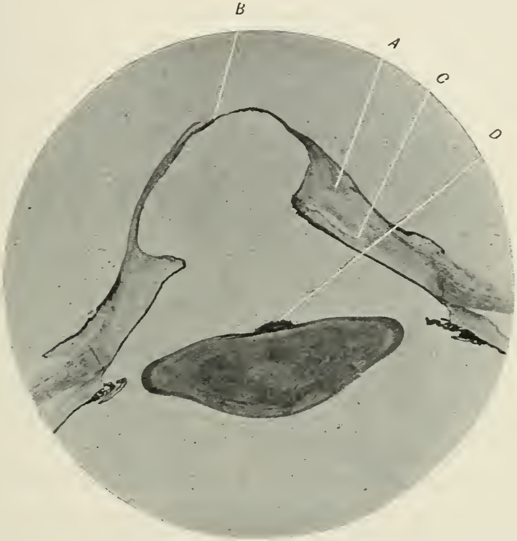


Fig. 47.—Anterior Staphyloma.

A. Substantia propria.
B. Staphyloma.
C. Iris adherent to the base of the old ulcer.
D. Anterior polar cataract.

4. If the ulcer is spreading, as shown by staining with fluorescin, the margins should be touched with pure carbolic or the electro-cautery.

5. In severe cases with hypopyon, especially where the tension of the eye is increased, division of the base of the ulcer and evacuation of the anterior chamber will often promote healing. (Saemisch's section.)

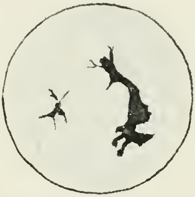


FIG. 48.—Dendritic keratitis. Appearance of the cornea after staining with fluorescin.

6. The general health of the patient should be improved by large doses of iron. In cases which are liable to perforate, the patient must be kept in bed. After the ulcer has healed, massage with Ung. hyd. ox. dil. will help the clearing of the resulting opacity. Where there is a large anterior staphyloma, excision or Mules' operation may be necessary.

2. NON-SUPPURATIVE. (*a*) *Superficial.*

1. **Vesicular keratitis** assumes one of four different types.

(*a*) **Dendritic keratitis** is herpes febrilis occurring on the cornea, and is often associated with herpes on the lip. There is usually a history of some febrile attack at the onset. Patients are subject to recurrent attacks of the disease. Vesicles first form on the cornea, break down, and form an ulcer of a peculiarly branching appearance (Fig. 48). Occasionally it becomes infected, leading to a purulent discharge from the ulcerated surface.

(*b*) **Herpes Zoster.**—In herpes zoster the cornea becomes covered with small vesicles which do not, as a rule, break down as in herpes febrilis. It is frequently associated with iritis and the eruption of vesicles along the course of the supraorbital, supratrochear and nasal branches of the 1st division of the 5th nerve. The disease is most intractable, is generally accompanied by great pain, and often leaves behind an interstitial opacity of the cornea.

(*c*) **Bullous Keratitis** is the formation usually of a single large vesicle on the cornea, not infrequently in the situation of an old scar. It is characterized by intense pain and repeated attacks of a similar nature. When the patient is examined for the first time nothing unusual may be visible on the cornea, as the vesicle is often healed when the patient comes under observation, but if carefully watched some disturbance of the epithelium is usually found.

Bullae of the epithelium also occur in eyes with increased tension and in cases of irido-cyclitis of long standing.

(*d*) **Superficial Keratitis punctata** is a condition in which minute bullae and erosions of the epithelium of the cornea occur, the onset of which is usually associated with a febrile condition. It is very apt to recur.

Treatment.—All forms of bullous keratitis are very intractable to treatment. By far the best remedy for dendritic and bullous keratitis, in addition to the treatment before described for corneal ulcer, is the actual cautery. Although the cases often heal readily under this treatment, they are very apt to recur.

2. **Pannus.**—*See* Trachoma.

3. **Mooren's Ulcer** is a rare condition in which a very chronic ulcer with undermined edges forms, involving about half the thickness of the cornea and never perforating. It is most resistant to treatment.

(*b*) *Deep Keratitis.*

1. **Interstitial Keratitis.**—Patients who are the subjects of this disease have suffered from congenital syphilis and often show the characteristic signs of this condition, especially the peg shaped teeth. It usually appears between the 6th and 20th years of life, although it may indeed occur earlier or later. It commences with pain and photophobia and on examination the cornea is seen to be infiltrated, giving it a ground glass appearance. The infiltration is situated deeply in the layers of the cornea (Fig. 49), usually commencing at the margins, and spreading towards the centre. Subsequently vessels invade the corneal tissue from the ciliary region and bright red areas (salmon patch) make their appearance. It is always accompanied by irido-cyclitis and deposits on the back of the cornea (keratitis punctata). The tension of the eye may be increased in the early stages or lowered in the later. The cornea, softened by infiltration, may yield under the intraocular pressure and thus a deep anterior chamber is formed. The opacity in the cornea clears from the periphery, the

central and lower part being the last to clear. The disease is usually associated with disseminated choroiditis, which is an earlier manifestation of congenital syphilis.

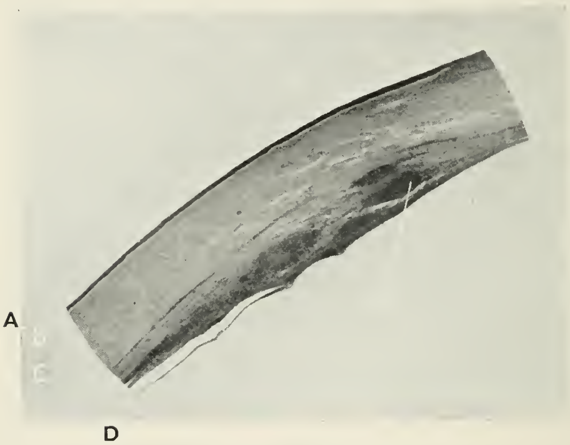


Fig. 49.—Interstitial keratitis.

A. Corneal Epithelium.
B. Bowman's membrane.
C. Substantia propria.
D. Descemet's membrane.
E. Round cell infiltration in the deeper layers of the cornea.

Diagnosis.—The bilateral nature of the disease, together with the other manifestations of congenital syphilis, are usually sufficient to render the diagnosis easy. But difficulty may arise when one eye only is affected. The presence of disseminated choroiditis in the other eye is often of great help. Tubercle of the iris is usually accompanied by an interstitial opacity in the cornea, which may complicate the diagnosis, but nodules on the iris, or failing that, the inoculation of the fluid from the anterior chamber into the guinea-pig, will generally solve the difficulty. Acquired syphilis may give rise to interstitial keratitis resembling the congenital form but when present it is often confined to one eye only.

For diagnosis from pannus (*see* pp. 99, 127).

Treatment.—Locally, in the acute stage, atropine should be instilled into the eye. If there is much pain and photophobia, leeching and hot fomentations are of service. The greatest attention must be paid to the general health of the patient. It is doubtful if mercury is of great value in this disease. Cod liver oil and fresh air with small doses of mercury are advisable. After the acute stage has subsided gentle massage with Ung. Hydrarg. ox. flav. dil. will assist in clearing the opacities. If one eye alone is affected the patient should be warned as to the probability of the other becoming involved.

3. **Sclerosing Keratitis** (*see* Episcleritis, p. 151).

4. **Striate Keratitis** is due to wrinkling of Descemet's membrane and cellular exudation into the deeper layers of the cornea. It occurs most frequently after operations requiring section of the cornea, such as operations for cataract extraction. It may also be seen in the early stages of cyclitis. It usually clears up after operation unless the wound becomes very septic.

DEGENERATION OF THE CORNEA.

Conical cornea is a condition in which the cornea yields under the normal intraocular pressure either as the result of some inherent weakness or as the result of interstitial inflammation or degeneration. The cone is formed with its apex situated near the centre of the cornea, and is easily distinguished as a rule by lateral observation, or by the use of the placido-keratoscope, or by the ophthalmoscope. The distortion of the fundus seen ophthalmoscopically may at first sight be mistaken for lenticonus but is easily disproved by lateral observation.

Treatment.—The vision can often be much improved by high + or – cylinders. If this is unsatisfactory a small elliptical piece can be removed from the apex of the cone. The apex, which is very thin, is transfixed by a fine Graefe knife and the tiny flap removed by a pair of fine iris forceps and scissors. After such an operation the anterior chamber will often take a week or two to form. The patient during this time is best kept in bed. Cauterization of the apex of the cone is an alternative treatment but is not so satisfactory, as the scar which is produced is apt to yield. A number of cases in which the operation has been performed have been followed by glaucoma, presumably, owing to the anterior chamber being empty for such a long period. An iridectomy has then to be performed in order to relieve the tension.

Arcus Senilis is a greyish band seen at the periphery of the cornea which usually makes its appearance first in the palpebral fissure. It can be distinguished from a nebula by the fact that there is a clear band of corneal tissue between it and the limbus. It is due to a fatty change in the substantia propria.

Band-shaped opacities across the cornea in the palpebral aperture are generally due to a calcareous change in Bowman's membrane and beneath the epithelium. They are often associated with iridocyclitis. When not due to this cause they may be removed by scraping, but are apt to re-form in the course of a year or two.

Nodular opacities are slightly raised, grey, irregular areas, which are usually most marked towards the centre of the cornea. They slowly increase in density and lead to very defective vision. The disease usually begins about puberty. Several members of a family may be affected, the disease being hereditary. Little or nothing can be done for the disease.

Tumours of the Cornea.—Papilloma, epithelioma, endothelioma, fibroma and myxoma have all been known to occur, but are very rare.

DISEASES OF THE SCLEROTIC

Anatomy.—The sclerotic with the cornea forms the fibrous envelope of the eye which is nearly globular; an emmetropic eye measures 24 mm. antero-posteriorly, and 24·5 mm. laterally. The sclerotic is composed of fine connective tissue bundles which are arranged both in a circular and antero-posterior direction. The bundles are separated by lymph spaces. The sclerotic is thicker behind than it is in front. It contains pigment cells along the course of the blood vessels. It is perforated by :

(1) the optic nerve—in this situation the sclerotic is represented by the lamina cribrosa.

(2) The posterior ciliary vessels and nerves situated around the optic nerve.

(3) The anterior ciliary vessels and nerves situated about 4 mm. from the corneo-sclerotic junction.

Injuries.—**Rupture** of the sclerotic is usually the result of a blow, such as by the fist, or by a door handle, on the globe. The blow generally falls on the outer side as it is more exposed, the rupture taking place on the inner side about 4 mm. behind the cornea, this being the thinnest part of the sclerotic. The lens with a portion of the ciliary body and iris is often extruded. The overlying conjunctiva may be intact.

Accidental wounds are generally the result of falling on some sharp foreign body. The great danger of such wounds is the incarceration of the iris and ciliary body.

Treatment.—Cleanse the eye and examine the wound. If large, and the lens is dislocated or injured, enucleation is usually advisable. Small wounds may be drawn together by a stitch in the episcleral tissue, and if the eye remains aseptic and settles down readily after the operation, it may be saved. But if still red after two or three weeks, or if keratitis punctata make its appearance, it should be enucleated, since injuries involving the ciliary region are amongst the commonest sources of sympathetic ophthalmia. In any case the prognosis to sight is bad, as even if all goes well for a time, detachment of the retina may follow some time after as the result of cicatricial contraction.

Punctured wounds of the globe are the result of (1) *sharp instruments*—darts, needles, etc.—these, if aseptic, and the lens not injured, heal rapidly. If the capsule of the lens is injured it is followed by a traumatic cataract. Immediately after the accident the tension of the eye is lowered and may remain so for some days owing to the escape and subsequent leaking of the aqueous. (2) *Flying pieces of metal, glass,* etc. (foreign bodies in the globe). The history of these accidents is usually the same. The patient is chipping with a hammer and chisel and a piece flies off and strikes the globe. In the case of glass it is usually a mineral water bottle which bursts. When seen the first thing to determine is whether the foreign body is in the eye. The following are the chief points in deciding :—

1. The position and nature of the wound in the cornea and sclerotic.

2. The condition of the anterior chamber—whether evacuated or not.

3. The tension of the eye, which may be lowered.

4. The presence of a hole in the iris.

5. Traumatic cataract.

6. The foreign body may be visible with the ophthalmoscope or by focal illumination.

7. The localisation of the foreign body by X Rays. This last is the most important factor of all, since the foreign body may pass right through the globe and be embedded in the orbit (Fig. 50).

Treatment.—*If the injury be a recent one* and the foreign body a piece of metal of magnetic properties it is best removed by an electro magnet after localisation by X Rays. If non-magnetic, such as a piece of copper cap or manganese steel, an attempt may be made to remove it with forceps after localisation. If the foreign body is embedded in the lens it is often advisable to remove the lens together with the foreign body. If glass, and especially when

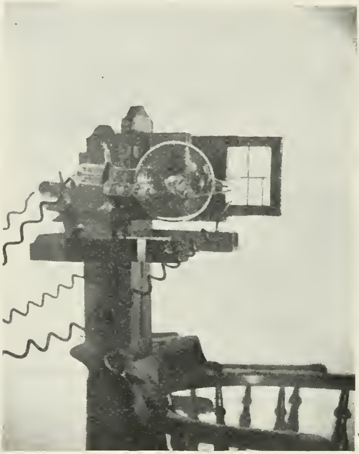


Fig. 50.—Author's chair and headpiece for the localisation of foreign bodies in the eye by X Rays.

only a small piece, it is usually best left alone unless capable of easy removal, e.g. if situated in the anterior chamber, since the eye will often tolerate well the presence of glass provided it be aseptic.

The eye should be removed:—

1. If the wound is obviously septic.

2. If the wound is very large, more especially if the lens be injured.

3. If the foreign body is a large piece of metal and cannot be extracted.

4. If the eye does not settle down after the operation, especially if irido-cyclitis with keratitis punctata have supervened.

If the injury is of long standing. It is little use attempting to extract foreign bodies in the eye after three days, unless they are loose in the vitreous or embedded in the lens, as they become surrounded by lymph. Under these circumstances it is better to leave them alone, or, if they are causing signs of irritation, to enucleate the eye.

Inflammation of the Sclerotic. — **Scleritis** occurs in two forms :—

1. Superficial (episcleritis). 2. Deep scleritis.

The three common causes of scleritis are (*a*) tubercle, (*b*) syphilis and (*c*) rheumatism. The onset of the disease is accompanied by intense pain, photophobia and lachrymation. The condition lasts for a considerable time and is apt to recur.

(*a*) *In the tubercular type* a large raised mass, with a yellowish centre, is usually present near the limbus. As a rule it does not extend deeply into the sclerotic, and therefore is not generally associated with cyclitis. The cornea may or may not be affected.

(*b*) *In syphilis* it usually takes the form of a gummatous infiltration and therefore affects the deeper layers of the sclerotic. It is accompanied by more or less constant pain with much swelling of the true sclerotic. Irido-cyclitis is usually present and the cornea is almost always involved (sclerosing keratitis), becoming opaque opposite the nodule. Subsequently the softened sclerotic may yield under the normal intra-ocular tension with the result that a *ciliary staphyloma* is formed. Rarely, both in syphilis and tubercle, the disease may start in the ciliary body and spread to the sclerotic.

(*c*) *The rheumatic form* is usually associated with chronic rheumatism or gonorrhœal arthritis. It is generally of the superficial type and as a rule no nodule is formed. The cornea may or may not be affected.

In recent cases, if there is doubt as regards the type to which it belongs, a piece of tissue may be removed and examined microscopically.

Treatment.—*Local.*—The pupils should be dilated with atropine, hot fomentations or dry heat should be applied. The eye should always be kept covered with a thick pad of wool. In the mild cases massage with dilute yellow oxide of mercury ointment is useful. *General.*—The administration of tuberculin T.R. and open air and tonics are most suitable for the tubercular cases ; iodide of potassium for the syphilitic ; potassium iodide and sodium salicylate for the rheumatic.

Ectasia of the Sclerotic.—Ectasia of the sclerotic occurs as a result of :—

1. Inherent weakness of the sclerotic primarily or secondarily to inflammation.
2. Increased intra-ocular tension.

The ectasia may be *total* or *partial.*

Total ectasia of the sclerotic must occur during early life so that all the fibres of the sclerotic yield, as in buphthalmia (*see* p. 271).

Partial ectasiae are :—

1. Anterior staphyloma, which has already been described (Figs. 46, 47).

2. Ciliary staphyloma as a sequela of scleritis, occurs in that region and presents a dark, slate-coloured prominence.

3. Equatorial staphyloma is the same condition occurring further back and is usually the result of prolonged intra-ocular tension.

4. Posterior staphyloma is of two kinds and can only be seen by the ophthalmoscope.

(*a*) Congenital, due to defect in the closure of the fœtal ocular cleft.

(*b*) Associated with myopia where a crescent first makes its appearance, followed by a complete ring round the disc.

Diagnosis.—The condition for which ciliary and equatorial staphyloma may at first sight be mistaken is a melanotic growth invading the sclerotic. The history, together with the tension and the examination of the fundus, is usually sufficient to render diagnosis easy. But in cases of doubt transillumination of the globe is of value.

Treatment.—Little can be done for the first two forms of the disease. In cases where there is much pain or disfigurement the eye should be removed.

Posterior staphyloma has been treated of under Myopia.

New growths of the sclerotic are very rare. Fibroma, sarcoma, and osteoma have been known to occur.

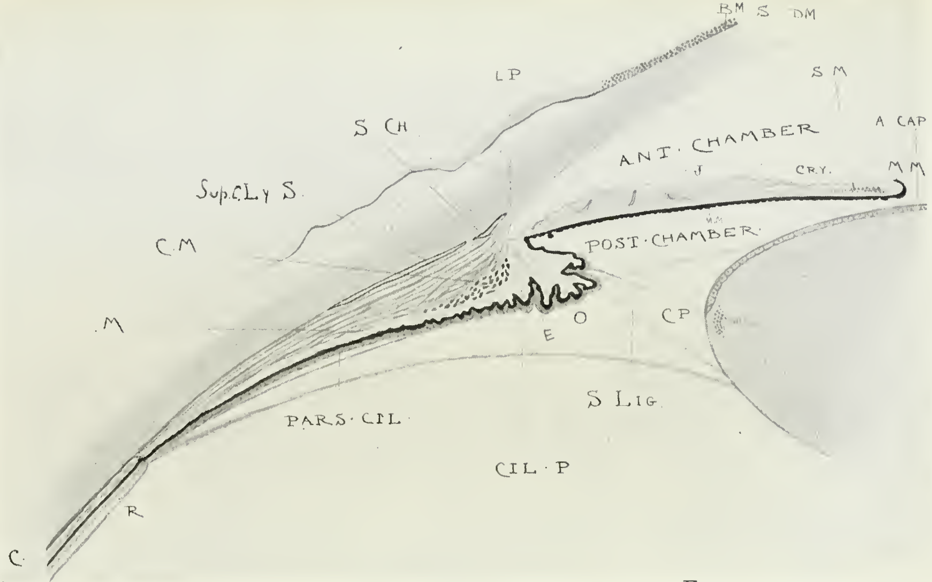
CHAPTER V

DISEASES OF THE IRIS, CILIARY BODY, AND CHOROID

Anatomy.—The iris, ciliary body and choroid together form the middle coat of the globe, known as the uveal tract. Diseases which affect one part of the tract involve also the neighbouring parts ; thus iritis is associated with cyclitis, cyclitis with choroiditis and iritis—though one may be much more marked than the other. The uveal tract has two gaps in its continuity—the optic nerve entrance and the pupil.

The iris is a membrane perforated about its centre by the pupil. At the periphery it is attached to the ciliary body, the attachment being situated about 2 mm. behind the limbus. From thence it extends forward to the pupillary border, being supported by the anterior capsule of the lens. If the lens is absent the iris becomes tremulous

To face page 157].



ANATOMY OF THE ANTERIOR SEGMENT OF THE EYE.

CIL. P. *Ciliary Process.*
S. CH. Canal of Schlemm.
L. P. Ligamentum Pectinatum between the fibres of which are the spaces of Fontana.
SUP. C. LY. S. Supra-choroidal lymph space, which extends backwards between the choroid and sclerotic.
M. Longitudinal portion of the ciliary muscle.
C. M. Circular portion.
E. Epithelium covering the ciliary process.
O. Circulus arteriosus.
PARS CIL. Pars ciliaris retinae. Pars plana of the ciliary body.

R. *The Retina.* } The junction of these with the pars
C. *The Choroid.* } plana is known as the *ora serrata.*
S. LIG. Suspensory ligament of the lens, between the fibres of which is the Canal of Petit (C. P.).
J. *Iris.*
S. M. Sphincter muscle.
CRY. Crypt.
M.M. Pigment epithelium.
S. *Cornea.* Substantia propria.
B.M. Bowman's membrane.
D.M. Descemet's membrane.
A. CAP. Anterior Capsule of the *lens.*

[Plate II.

(irido-donesis). On looking at the surface of the iris two zones are noted : an inner, or circulus minor, and an outer, or circulus major. At the pupillary margin can be seen the black pigment of the uvea which comes forward on to its anterior surface in that region.

Microscopically the layers of the iris are from before backwards :—

1. The anterior layer of endothelial cells.

2. The anterior limiting membrane. Both of these are the continuation of Descemet's membrane and the endothelial cells lining its posterior surface.

3. A stroma of very vascular tissue containing pigment cells, towards the free margin of which is the sphincter muscle.

4. The posterior limiting membrane, corresponding to Bruch's membrane in the choroid.

5. The pigment cells continuous with the retinal pigment layer.

The colour of the iris depends on the amount of pigment in the stroma. Thus when children are born they have blue eyes, due to the dark pigment seen through the stroma, but as pigment is developed in the stroma they may become brown. The two irides and even choroids may be of different colours (congenital heterochromia). But this condition must be carefully distinguished from the form due to cyclitis, which may easily be overlooked unless keratitis punctata and other signs of cyclitis are most carefully looked for.

The interior of the eyeball in front of the lens is divided into two parts by the iris diaphragm, that between the iris and the posterior surface of the cornea being called the anterior chamber, while that between the iris and the suspensory ligament of the lens constitutes the posterior chamber; these divisions communicate through the pupil.

The ciliary body is best seen by cutting the eye open and removing the retina and lens. The point where the retina tears off in front is known as the ora serrata. Behind this is the choroid; in front is the ciliary body. The ciliary body is seen as a number of folds (ciliary processes), surrounding the lens. If the ciliary body be stripped off from the sclerotic the ciliary muscle is exposed. It has two sets of fibres: (*a*) external or circular fibres; (*b*) internal or longitudinal fibres. This muscle is called into action by the effort of accommodation. The ciliary processes consist of extremely vascular connective tissue covered by a thin membrane and pigment epithelium. One of the chief functions of these processes is to secrete the aqueous humour which fills the anterior and posterior chambers.

The ciliary body is attached to the sclerotic behind the corneo-scleral junction by means of the ligamentum pectinatum which fills up the angle of the anterior chamber formed by the iris and posterior surface of the cornea. Through the meshes of the ligamentum pectinatum the aqueous humour filters into the canal of Schlemm which is situated at the corneo-scleral junction. Blocking of this angle by the root of the iris becoming approximated to the posterior surface of the cornea causes increased tension in the eye (glaucoma).

The choroid is the part of the uveal tract behind the ora serrata. It consists of the following layers from without inwards :—

1. The lamina supra-choroidea—the fibrous pigmented outer surface.

2. The large vessel layer.

3. The intermediate sized vessel layer.

4. The small vessel layer (chorio-capillaris).

5. Bruch's membrane, composed of two parts, the outer of which consists of elastic tissue. Embryologically the inner layer of this membrane belongs to the retina since it is deposited from the retinal pigment cells which lie on it.

The stroma contains many large branched pigment cells. The extreme vascularity of the choroid renders it somewhat similar to erectile tissue. It is supplied by the anterior and posterior ciliary arteries which anastomose about the equator of the globe. The blood is carried away by the large venæ vorticosæ. The blood vessels of the choroid can be seen with varying distinctness (depending on the amount of pigment) through the retina by means of the ophthalmoscope.

The choroidal vessels anastomose with :—

(1) The retinal vessels around the disc (circle of Zinn) and may even replace one of the branches of the retinal artery and veins (cilio-retinal vessels).

(2) The posterior conjunctival vessels which

anastomose with the anterior ciliary vessels, thus accounting for the dilatation of the conjunctival vessels in iritis.

The **lymph passages** of the eye are :—

1. *Anterior*—the anterior chamber and canal of Schlemm.

2. *Posterior*—hyaloid canal, perichoroidal space—along the course of all the vessels where the latter leave the globe, the supra and inter-vaginal lymph spaces in connexion with the optic nerve, and Tenon's capsule.

Physiology.—The iris forms the diaphragm of the eye as an optical instrument. It is supplied by the 3rd nerve through the lenticular ganglion and the ciliary nerves, stimulation of which gives rise to contraction while paralysis causes dilatation of the pupil. It is also supplied by branches from the sympathetic, stimulation of which leads to dilatation, while paralysis produces contraction of the pupil.

Reflex stimulation may be *direct* or *associated.*

1. Direct.—(*a*) *Light.*—Light falling on the retina of either eye causes contraction of the irides of both

eyes. If light is thrown into one eye and the opposite pupil contracts it is known as consensual reaction and is of great use in determining whether an eye has sensation of light or not. Oscillation of the pupil is known as "hippus."

(*b*) *Sensory stimuli*, such as pinching the neck, cause contraction of the pupil. In sleep the pupils are contracted but they immediately dilate on waking. Strong psychic stimuli, e.g. fright, produce dilatation.

2. Associated reaction always gives rise to contraction.

(*a*) with convergence,

(*b*) with accommodation.

Reaction of the Pupil to Drugs.—*Atropine* paralyses the sphincter and ciliary muscles and causes dilatation of the pupil (mydriasis) lasting for a week or more after its use has been discontinued. It passes into the aqueous from the conjunctival sac by diffusion. Atropine poisoning causes dryness of the throat, nausea, faintness and formication; it usually results from the drug finding its way down the nasal duct, but this can be obviated by pressure over the sac for a short time after instilling the drug, or by using atropine in the form of an ointment. Dilatation of the pupil caused by atropine may bring on an attack of acute glaucoma in persons predisposed to the disease by blocking the angle of the anterior chamber; it should therefore be used with caution for refraction after the age of twenty-five and be avoided in old people for all diseases of the eye, except those liable to involve the uveal tract.

Eserine causes tonic contraction of the sphincter and ciliary muscles so that the pupil is pin point (miosis). The contraction draws away the root of the iris and so frees the angle of the anterior chamber.

Cocaine dilates the pupil both by stimulation of the dilator fibres (sympathetic) and contraction of the blood vessels; if the sympathetic be paralysed dilatation does not take place. Further it blanches and anæsthetizes the conjunctiva, and renders the palpebral fissure more widely open (sympathetic stimulation). Strong solutions cause desiccation of the epithelium of the cornea.

Development.—The eyes are developed from two pedunculated outgrowths of epiblast, primary optic vesicles, from the sides of the fore brain, the pedicle subsequently forming the optic nerve. The surface epiblast opposite the protrusion becomes thickened and invaginated, thus forming a secondary optic vesicle or lens. The secondary vesicle causes an indentation and invagination of the primary vesicles so that it becomes folded in on itself, except below, where a gap is left for the entrance of the mesoblast (vitreous, retinal and hyaloid vessels); this is known as the fœtal ocular cleft. The outer wall of the primary optic vesicles goes to form the pigment cell layer of the retina, whilst the inner forms the retina proper.

The mesoblast growing in from the sides separates off the lens from the surface and forms the cornea. The lens is again separated off from the cornea by the ingrowth of the iris. The anterior chamber is not developed until about the seventh month of fœtal life. The nutrition of the fœtal lens is carried out by a vascular capsule which derives its blood supply :—

1. Posteriorly, from the hyaloid artery which is the continuation forwards of the central artery of the retina to the back of the lens where it passes forward by numerous branches to the anterior surface.

2. Anteriorly, through the pupillary membrane which is supplied by vessels from the outer circle of the iris.

The eyelids are derived from folds above and below the cornea which grow together and are joined by an epithelial bond of union up to the end of the fifth month of fœtal life.

THE IRIS

Congenital Abnormalities. — **Persistent pupillary membrane** is composed of fine filaments, the remains of blood vessels forming the vascular sheath of the lens which run from the iris on to the anterior capsule of the lens. They are distinguished from posterior synechiæ by the fact that they spring from the circulus major of the iris (Fig. 51).

Polycoria (multiple pupils) is due to imperfect development of the iris and want of disappearance of the pupillary membrane.

Aniridia (absence of the iris) is never complete as there are always some stumps of the iris attached to the ciliary body. Patients who have this condition usually develop glaucoma later in life owing to the imperfect formation of the angle of the anterior chamber.

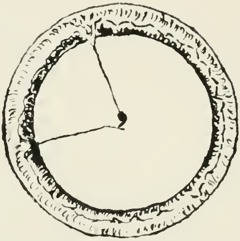


Fig. 51.—Persistent pupillary membrane. The remains of the anterior portion of the fœtal vascular capsule of the lens. Note that this originates from the outer circle of the iris. Compare with Fig. 52.

Coloboma of the iris nearly always occurs below and is due to imperfect closure of the fœtal ocular cleft. It is often associated with coloboma of the choroid and optic nerve.

Injuries.—Injuries usually occur as the result of a blow on the eye which may or may not perforate the cornea, and are usually followed by hæmorrhage into the anterior chamber (hyphæma).

1. **Irido-dialysis** is the separation of the iris from the ciliary body, the pupil opposite the rupture having lost its rounded form becomes flattened ; if large and the media clear, the fundus and suspensory ligament of the lens can often be seen through the gap. Monocular diplopia may be present.

2. **Radial laceration of the iris** may occur but is rare.

3. **Inversion of the iris** clinically has the appearance of absence of the iris but in reality this is doubled back over the ciliary body ; the defect is usually only partial and is the result of a blow on the front of the eye. It has to be diagnosed from rupture of the ligamentum pectinatum in which the ciliary body, carrying with it the iris, retracts and pulls the iris out of sight.

Treatment.—Atropine should be instilled and the eye tied up ; ice compresses in the early stages are advisable. If perforation or rupture has taken place it should be treated as described under wounds of the cornea.

Inflammation. — Iritis. — Irido-cyclitis. — Ætiology.—Iritis or irido-cyclitis, unless due to direct injury or spread of inflammation from surrounding parts (secondary iritis) must be of metastatic origin ; that is to say, some organism is deposited from the blood and sets up an inflammation in the neighbourhood. The chief known causes are : (1) syphilis, (2) tubercle, (3) gonorrhœa, (4) rheumatism, (5) infective diseases, e.g., cerebro-spinal meningitis, typhoid, chronic pyæmia (often staphylococcal), (6) sympathetic inflammation.

The disease may be *acute* or *chronic*, the latter form being always associated with cyclitis. Syphilis, gonorrhœa, rheumatism, the acute infective diseases, and one form of pyæmia all cause acute iritis ; whilst tubercle, chronic pyæmia and sympathetic ophthalma cause chronic iritis.

The disease is also divided into :—

1. **Plastic Iritis,** in which there is much exudation of lymph and many adhesions of the iris to the anterior capsule of the lens (posterior synechiæ) as in syphilis (Fig. 52).

2. **Serous Iritis** where there are a few adhesions, as in the form associated with gonorrhœal rheumatism.

As has already been pointed out, iritis does not occur without some cyclitis. The following points indicate serious involvement of the ciliary body.

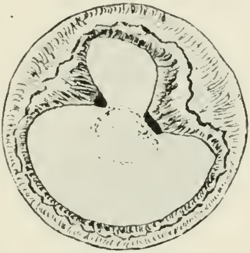


FIG. 52.—Posterior synechiæ following iritis. The margin of the iris is adherent to the anterior capsule of the lens. Some pigment from the posterior surface of the iris is also adherent.

1. Œdema of the upper lid.

2. Tenderness on pressure in the ciliary region.

3. Deposits on the back of the cornea (keratitis punctata).

4. Vitreous opacities.

5. Alteration in tension + or —.

Acute Iritis.—Symptoms.

1. *Pain.*—Pain is usually referred to the supra-orbital region and is worse at night. Absence of pain and photophobia is one of the characteristics of the form associated with pyæmia.

2. *Ciliary injection* is the dilatation of the vessels of the ciliary region and ocular conjunctiva. The ciliary vessels can be distinguished from the conjunctival in that they produce a purplish discolouration without any individual vessels being visible, whilst the conjunctival vessels move with the conjunctiva.

3. Contraction of the pupil is present owing to the engorgement of the iris with blood.

4. Sluggishness or want of reaction to light as a result of vascular engorgement or of the formation of adhesions to the anterior capsule to the lens (posterior synechiæ) (Fig. 52).

5. Discolouration of the iris, due to exudation into its substance.

6. Loss of pattern, due to fibrinous exudation on the surface.

7. Turbidity of the aqueous and even hypopyon

may be present, the latter being usually associated with the forms due to acute infectious diseases.

Chronic Iritis.—Any or all of the above symptoms may be present to a greater or less extent. The pain and ciliary injection may be absent ; the discolouration is usually marked ; in the more chronic cases the most constant sign is the presence of keratitis punctata (Fig. 53), a deposit of cells in round masses on the back of the cornea, which tend to take a triangular form, the base being directed downwards due to the movements of the eye. The masses are larger below than above owing to gravity, and when they are very large, as in

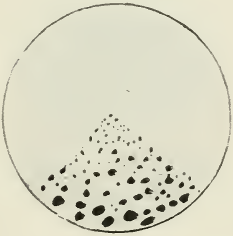


FIG. 53.—Keratitis punctata (K.P.). Due to the cellular exudation in cyclitis being deposited on the back of the cornea. The triangular form is due to the movements of the eye.

tubercle of the iris, they are known as "mutton fat K. P."

Large gelatinous nodules are usually associated with tubercle but may also occur in syphilis (late secondary) (Fig. 54).

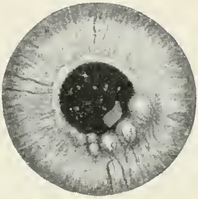


Fig. 54.—Tubercle of the iris. The dots seen in the pupil are keratitis punctata on the back of the cornea; it is usually of the "mutton fat" variety.

In the early stages the tension of the eye is often raised owing to increased secretion and the albuminous nature of the fluid secreted from the ciliary body, whilst in the later stages it is lowered as a result of atrophy.

Vitreous opacities due to exudation from the ciliary body behind the lens are usually present except in the tubercular forms. Choroiditis may also be present.

Complications.—*Posterior synechiæ* (Fig. 52), or adhesions of the iris to the anterior capsule of the lens, almost invariably accompany the disease. When they occur all round the margin of the iris the condition is known as *excluded pupil* (Fig. 55). If the exudation covers the anterior capsule of the lens in the pupillary area as well, it is called *occluded pupil.* As the result of this total exclusion the aqueous, which is secreted by the ciliary body, causes the iris to bulge forward (*iris bombé*) (Fig. 55). This blocks the angle of the chamber causing increased tension of the eye, *secondary glaucoma* (Fig. 55). Increased tension in the early stage of cyclitis may also arise from the increased secretion and imperfect absorption through the canal of Schlemm of the highly albuminous aqueous humour.

Recurrent attacks are frequent in the gonorrhœal and the more chronic forms. They lead to atrophy of the iris as shown by its thin bleached appearance (heterochromia iridis).

Exudates from the ciliary body interfere with the nutrition of the lens which may become opaque (*cataract*). The contraction of the organized exudate from the ciliary body may cause *detachment of the* *retina* and even *shrinking of the whole globe.* The result of organization of the choroidal exudation may lead to calcareous and even bony formation.

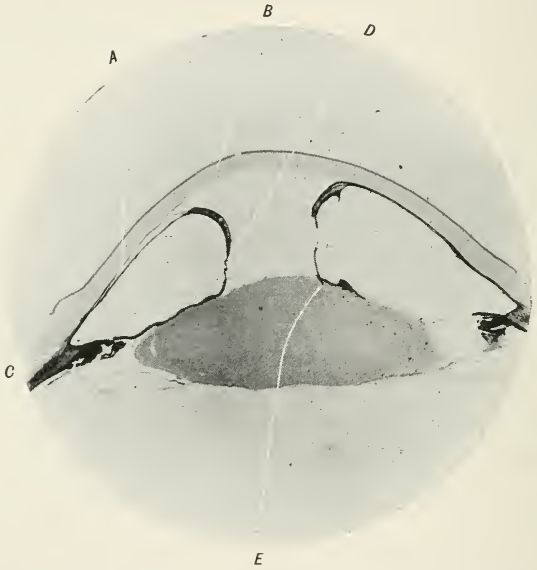


FIG. 55.—Iris bombé from a case of secondary glaucoma.

A. The iris is closely applied to the back of the cornea *B*, occluding the angle of the anterior chamber *C.* The margins of the iris *D*, together with some pigment from the posterior surface of the iris, are still adherent to the anterior capsule of the lens *E* (posterior synechiæ).

Diagnosis.—In the early stages it may be difficult to diagnose from conjunctivitis. The fact that the ciliary vessels are enlarged, together with the sluggish reaction of the pupil and perhaps some blurring of the pattern of the iris, are usually sufficient to decide the question. (For differential diagnosis from glaucoma *see* Glaucoma.)

Treatment.—*Local.*—Atropine should be instilled into the eye to dilate the pupil as rapidly as possible in order to prevent and break down posterior synechiæ. Cocaine may be used with the atropine in the early stages to relieve the pain and assist the action of the atropine by contracting the blood vessels. Leeching to the temple is of use if the pain be severe. Dry heat applied by means of a pad of wool placed over the eye and a charcoal muff warmer or electric heater fixed in position is also of service; in the interval dark glasses should be worn.

Increased tension, if due to acute effusion from the ciliary body, is best treated in the early stages by paracentesis, but if due to iris bombé, can only be relieved by performing iridectomy in order to establish again the communication between the anterior and posterior chambers.

In an occluded pupil an iridectomy will often prevent the onset of secondary glaucoma and may improve vision. Operations on eyes with keratitis punctata are only to be undertaken when absolutely necessary.

General.—In syphilis mercury should be administered internally or by inunction. In the rheumatic forms iodide of potassium and sodium salicylate are of service. Hot vapour baths are also useful.

In the gonorrhœal and *rheumatic* forms the prognosis should be guarded as the attacks are very liable to recur, even after an interval of years. Some good results have been obtained by vaccination with the gonococcus. In tubercle the general health and hygienic surroundings should be improved; tuberculin T. R. has been given with success in many cases. The nodules disappear in about four weeks but the persistent irido-cyclitis is often very slow in subsiding. In advanced cases enucleation is sometimes necessary.

Chronic Pyæmia is associated with two types of iritis: (1) An *acute* variety, in which a painless hypopyon forms in the anterior chamber (Fig. 56), may end in resolution or, where the exudation exists in the vitreous and goes on subsequently to organization, in the condition known as pseudo-glioma. Or again general panophthalmitis may ensue.

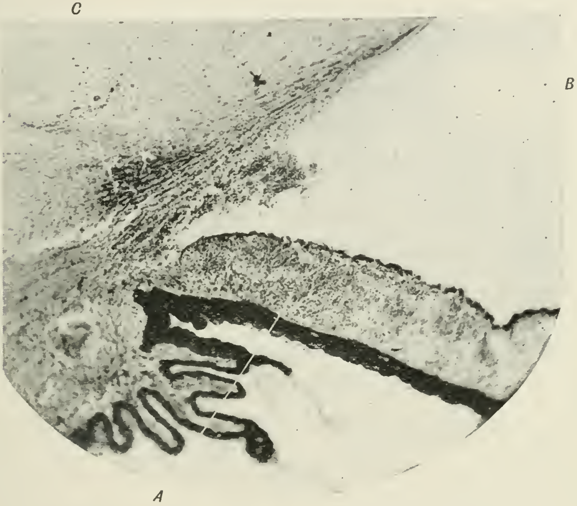


FIG. 56.—Acute Iritis with Hypopyon.

A. Cellular exudation into the iris.
B. Pus cells in the angle of the anterior chamber (hypopyon).
C. Canal of Schlemm.

The disease is not infrequently associated with middle ear trouble. Cases of hypopyon from this cause should be evacuated as soon as possible. In the case of general panophthalmitis the eye should be eviscerated.

(2) The *chronic* form usually shows itself as a painless cyclitis with little or no ciliary injection. Keratitis punctata is always present and the disease is characterized by its extremely slow course, often lasting for years. After a time the iris becomes atrophic and discoloured and the lens may become opaque. It, as a rule, only affects one eye, and may or may not be associated with visible choroiditis. The source of infection is often some septic trouble such as decayed teeth, leucorrhea, boils; indeed, staphylococcal lesions seem to predominate. Some of these cases have been successfully treated by staphylococcus vaccine.

Sympathetic Irido-Cyclitis (sympathetic ophthalmia) occurs as the result of inflammation set up by a wound of the globe most commonly situated in the ciliary region in one eye (exciting eye) causing an irido-cyclitis in the other eye (sympathising eye). The other most common causes are foreign bodies in the globe, and cataract extraction in which there has been a prolapse of the iris. The shortest time that it has been known to follow the original injury is three weeks.

Symptoms.—The onset in the sympathising eye is often accompanied by blurred vision, pain, slight photophobia and ciliary flush. These symptoms are known as *sympathetic irritation.* Then follows a very plastic iritis with marked keratitis punctata, which is always present and is sometimes the first sign of onset. There is always keratitis punctata in the exciting eye. The disease usually progresses in spite of all treatment, the tension being often raised or lowered; a shrunken globe (phthisis bulbi) may be the ultimate result.

The most satisfactory explanation of the disease is that it is a chronic septic condition of the exciting eye following a penetrating wound and that the toxin, or organism which produces it, is carried by the blood stream to the sympathising eye, setting up an irido-cyclitis in it. Suppurating eyes never cause sympathetic ophthalmia unless they contain a foreign body.

Prophylaxis.—Since prolapse of the iris and ciliary body is one of the most fertile sources of sympathetic ophthalmia it is most important at the time of injury or operation carefully to remove or replace all portions of the uveal tract. The appearance of keratitis punctata in an eye with such a wound renders enucleation probably advisable.

Treatment.—All the general lines for the treatment of irido-cyclitis should be followed. If the exciting eye is blind it should be enucleated at once. If the exciting eye has fair vision and the disease has well advanced in the sympathising eye it may not be advisable to enucleate the exciting eye.

The administration of mercury until salivation has been produced has done good in some cases.

Tumours of the Iris.—**Cysts** of the pigment epithelium of the iris are not infrequent after inflammation. They produce a local iris bombé. They are liable to be mistaken for sarcomata, but are usually distinguished by the signs of old inflammation.

Sarcomata are extremely rare, most commonly starting in the ciliary body near the root of the iris and showing in the angle of the anterior chamber as small nodules. They are usually very pigmented (melanotic), but occasionally are non-pigmented (leuco-sarcoma).

THE CHOROID.

Congenital Abnormalities.—**Coloboma of the Choroid** is due to the imperfect closure of the fœtal ocular cleft and is frequently associated with coloboma of the iris and optic nerve. It may also be accompanied by congenital opacities in the lens. The eyes are often small and ill developed (microphthalmos). On examination, in the lower part of the fundus can be seen a large white area (sclerotic) over which the retinal vessels can be seen. The edges are sharp and often pigmented, and there is a defect in the visual field corresponding to the coloboma.

Coloboma of the Macula is usually seen as a whitish area with pigmented margins. It has been attributed to the imperfect development of the choroidal vein in that situation.

Albinism consists in the absence of pigment from the fundus, iris, and usually the hair. The patients have the appearance of having pink eyes. With the ophthalmoscope the choroidal vessels are easily seen with the white sclerotic as a background. The patients generally have nystagmus, are usually myopic, but are not much improved by correction of the refractive error ; they are much relieved, however, by the use of dark glasses.

Injuries.—**Ruptured Choroid** is produced by a blow on the eye with a blunt instrument. The rupture usually takes place to the outer side of the disc, is most frequently vertical in direction, and is generally curved concentrically with the disc. At first the vitreous is often full of blood so that no details can be seen. Afterwards the rupture appears as a white streak with pigmented edges, the retinal vessels passing over it uninterruptedly.

Inflammation of the Choroid.—Choroiditis is divided into : 1. Suppurative ; 2. Non-suppurative.

1. SUPPURATIVE INFLAMMATION occurs as part of a commencing general *panophthalmitis* as the result of a wound or metastatic infection.

Symptoms.—The lids and conjunctiva are red, swollen and œdematous ; the aqueous and cornea cloudy ; hypopyon may be present. Pain is intense except in the metastatic forms in which it is usually absent. If the cornea, aqueous and lens are clear, a yellow reflex is obtained from the fundus due to the pus exuded into the vitreous. The disease may go on to: (1) panophthalmitis with rupture of the globe and extrusion of the contents; (2) resolution with (*a*) shrinking of the globe (phthisis bulbi), (*b*) pseudo-glioma, in which a yellow organized mass remains behind the lens, clinically resembling very closely a true glioma of the retina.

Treatment.—Suppurating eyes are best opened by removing the cornea, turning out the entire contents of the globe and flushing out the cavity with an antiseptic. They should never be enucleated since division of the optic nerve opens up the dural sheath and so may lead to the direct spread of the organism to the meninges. Shrunken globes may be removed for cosmetic reasons.

2. NON-SUPPURATIVE.—**Symptoms.** Failure of sight is often the first symptom. It may come on gradually or suddenly. Especially is this so if the macular region is affected. The patients complain of spots before the eyes, flashes of light, or scotomata in the field.

Exudation into the choroid can only be seen with the ophthalmoscope. It is often impossible to say whether a mass of exudation is in the choroid or in the retina. If the retinal vessels cross over the patch it shows that it must be either in the deep layers of the retina or in the choroid. The inflammation in the choroid usually affects the overlying retina which may participate in the inflammation, the amount of defective vision depending on the extent to which the retina is involved. The exudation may extend into the vitreous and is then usually seen as opacities.

The choroid is usually affected with scattered foci of inflammation. In the early stages these make their appearance as soft greyish red patches which subsequently organize into white atrophic areas. Around these the pigment cells proliferate, giving rise to the formation of black masses; especially is this the case at the margins of these white areas. The overlying retina is often rendered functionless and atrophic, leading to scotomata in the field of vision, the retinal pigment cells proliferate and migrate into the patches (Fig. 57).

The disease is of long duration, often taking many

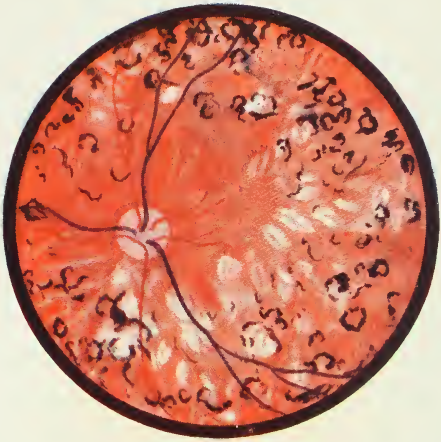


FIG. 1.—DISSEMINATED CHOROIDITIS, FROM A CASE OF CONGENITAL SYPHILIS.

Note the large white areas of choroidal atrophy and pigmentation. The disc and vessels are almost normal. (Compare Plate IV., Fig. 1.)

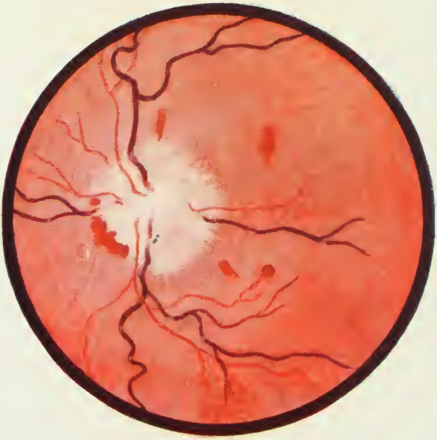


FIG. 2.—OPTIC NEURITIS, FROM A CASE OF CEREBRAL TUMOUR.

Note the blurred swollen disc, engorged tortuous veins, and retinal hæmorrhages.

To face page 185.] [*Plate III.*

weeks to settle down. The opacities in the vitreous may remain for months after all inflammation has subsided. Secondary vascular sclerosis in the choroid may lead to defective nutrition of the retina causing night blindness; the lens may also become opaque from malnutrition.

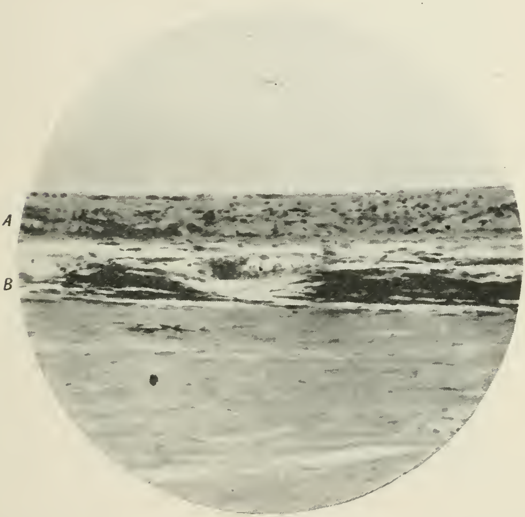


FIG. 57.—Syphilitic disseminated choroiditis (*see* Plate III).
A. Atrophic pigmented retina.
B. Atrophic pigmented choroid.

Ætiology.—*Syphilis* is by far the most common cause of the disease, especially the congenital form.

Disseminated choroiditis (congenital syphilis) (Fig. 57 and Plate II) occurs usually during the first few weeks of life but is rarely observed until the child begins to grow up. It is commonly more marked in the periphery of the fundus than elsewhere but often the whole of the choroid may be affected. It always affects both eyes and is liable to be followed by interstitial keratitis at a later date. Vitreous opacities are usually present.

In the *acquired form* the changes in the fundus are similar, but the disease may only affect one eye.

Tubercular choroiditis.—Tubercle affects the choroid in two forms : (*a*) *solitary tubercle* with diffuse infiltration of the choroid. This is a rare disease which leads to large white masses of exudation with practically no pigmentation. With the ophthalmoscope it is liable to be mistaken for a new growth. Vitreous opacities are usually absent.

(*b*) *Miliary tubercle* accompanies general tuberculosis or meningitis. It may be of diagnostic importance in doubtful cases of this nature. The tubercles may be single or multiple and appear ophthalmoscopically as round white areas slightly raised, with soft edges and no pigmentation. It may or may not be accompanied by optic neuritis (Figs. 58 and 59).

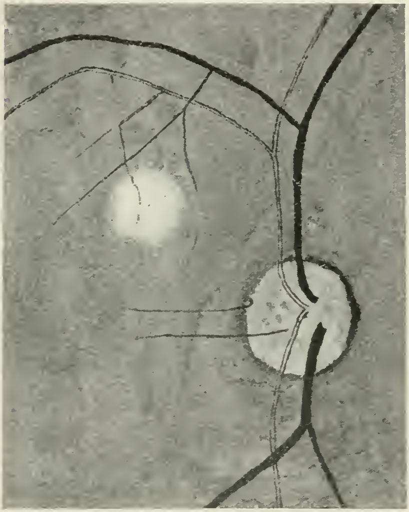


Fig. 58.—Tubercle of the choroid (miliary) from a case of general tuberculosis.

Septic choroiditis is a form of pyæmic infection which does not go on to suppuration, the source of infection being often bad teeth, leucorrhœa, boils, etc. Clinically it is often indistinguishable from the syphilitic form, but is more frequently associated with a quiet cyclitis and keratitis punctata.

Malaria and other forms of tropical diseases may give rise to choroiditis with excess of pigmentation.

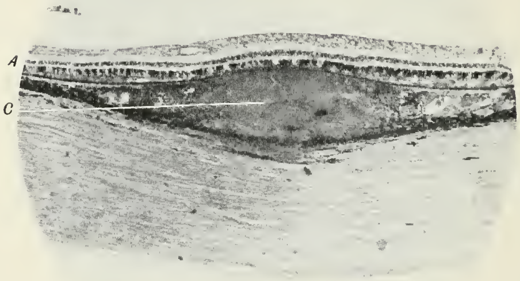


FIG. 59.—Tubercle of the choroid.

A. Retina.
B. Sclerotic.
C. Tubercle in the choroid.
In this case it was the first manifestation of general tuberculosis.

Treatment and Prognosis.—Locally the eye should be protected with dark glasses. If one only is affected a shade may be worn. Local blood letting by leeches to the temple is of use. If cyclitis is present atropine should be used.

In the syphilitic form which occurs in the secondary stage, corresponding to the papular rash, mercury by inunction should be given. The prognosis is fair if seen early.

In solitary tubercle the administration of tuberculin controlled by the opsonic index, combined with improvement of the general health, often leads to resolution ; but if the disease advances in spite of treatment, enucleation may be advisable, especially if the diagnosis from new growth is doubtful.

In the miliary form the prognosis to life is bad, since the disease is practically always accompanied by general tuberculosis or tubercular meningitis.

Vascular Sclerosis of the Choroid (Tay's choroiditis) (*see* Retina, p. 214).

Tumours of the Choroid may be : (1) primary, these are usually sarcomata ; (2) secondary or metastatic, these being usually carcinoma.

Sarcoma.—*Pathology.* Sarcomata may be : (1) melanotic ; (2) leuco-sarcoma. They commence to grow from the pigment cells and stroma of the choroid respectively. At first they form a more or less rounded tumour which after a time ruptures through the membrane of Bruch, forming a mushroom shaped growth. This subsequently makes its way along the course of the vessels and nerves at their entrance into the globe and forms secondary deposits in the orbit. Finally the disease may become disseminated throughout the system.

A rare form of sarcoma in which the growth does not fungate (*flat sarcoma*) does occasionally occur; it is probably of the nature of an endothelioma, extra-ocular nodules occur early in the disease.

Symptoms and Diagnosis.—Clinically a growth in the choroid may present itself in one of four stages :—

1. *Retinal detachment* is the early sign and is due to the growth pushing forward the retina and to the effusion of fluid between it and the growth. In this stage it is often most difficult to diagnose from other causes of detachment. The chief points in favour of a growth are : (*a*) new vessels of the growth seen through the detachment ; (*b*) pigmen-

tation ; (*c*) hæmorrhages into the retinal tissue ; (*d*) more than one retinal detachment is also suggestive although by no means a sure sign.

2. *Glaucoma*, which is often extremely acute, no fundus details being observed. The previous history of bad vision, etc., is often useful in confirming the diagnosis.

3. *Extra-ocular spread of the tumour* may show itself by a nodule under the conjunctiva or by proptosis of the whole eye. In this stage it must be distinguished from an equatorial staphyloma.

4. *General dissemination of the growth*, secondary tumours being found in the skin, liver, etc.

Melanotic sarcomata of the choroid are peculiarly malignant. If seen in the first or second stages the prognosis is good, but if in the third or fourth bad.

Treatment.—In the first and second stages enucleation of the eye, cutting the nerve as far back as possible. If in the third stage evisceration of the orbit is necessary. In the fourth stage palliative treatment is all that is possible. The patients rarely live longer than two years.

Carcinoma is usually secondary to scirrhus of the breast. Unlike sarcoma it forms a flat growth in the choroid and is also accompanied by retinal detachment and glaucoma. If pain is acute enucleation is advisable.

CHAPTER VI

DISEASES OF THE LENS

The lens lies between the vitreous and aqueous chamber and is held in position by the suspensory ligament, which is attached to the equator of the lens on the one hand and the ciliary body on the other by numbers of interlacing fibres. The tension on these fibres accounts for the flattened lenticular shape ; hence a lens removed from a young eye assumes a rounded form.

Development.—In its early stage it consists of a solid rounded mass of cells budded off from the epiblast. This subsequently becomes a hollow vesicle lined by a single layer of epithelial cells and enclosed in a thin elastic membrane (lens capsule). It is surrounded by a vascular capsule supplied by the hyaloid artery and anterior ciliary vessels (pupillary membrane) which disappears shortly before birth. The fibres are formed by the cells lining the posterior surface of the capsule growing forward to fill up the cavity, thus forming again a solid body. Hence, when the lens is fully developed, the posterior capsule has no lining cells since they have formed the lens fibres. Gradual development of the lens goes on throughout life, but the actual bulk does not increase to any extent as the fibres merely become more closely packed together and lose some of their fluid (sclerosis). Hence the older fibres, i.e. the central part, are the first to sclerose, which accounts for the fact that the lens is less translucent in old people. It is this part also which forms the hard nucleus of a senile cataract. The fibres are deposited in lamellæ like the layers of an onion and are joined together side by side so that the cemented material forms a stellate figure on the surface. When the fibres are opaque, as in cataract, they form a striate figure (striæ) (Figs. 60 and 61).

The nutrition of the lens is carried on by a process of osmosis through its capsule, principally from the blood vessels of the ciliary body. Hence changes in that body, such as cyclitis, are liable to lead to opacities in the lens.

Chemically the lens is composed of crystallin, which is nearly related to serum globulin, and therefore soluble in a saline solution. Hence a wound in the lens capsule allows the saline aqueous to act on the lens fibres which swell up and become opaque, finally being absorbed if sclerosis is not present—a most important factor in the treatment of cataract. Thus the lens of a patient under the age of twenty-five should be needled, but after that age extraction of the nucleus should be performed.

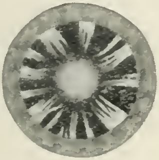


Fig. 60.—*Senile cataract.*—Seen by focal illumination.

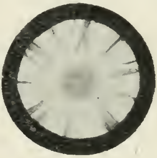


Fig. 61. — Seen with the ophthalmoscope. The central opacity is nuclear ; the marginal, peripheral striæ.

Cataract, or opacity of the lens, is due to an alteration in the density of the structure ; as for example, water shaken up with air looks opaque, so the alteration in density in the different parts of the lens makes it also appear opaque. Cataract may be *partial* or *complete*, *stationary* or *progress-*

ive, *congenital* or *acquired*. The opacity may be situated in the lens or its capsule. The opacities in the lens are best seen by focal illumination when they appear white in the dark ground of the pupil, or by the direct ophthalmoscopic mirror and + 20 D behind it, when they appear black on the red ground of the fundus reflex (Figs. 60 and 61).

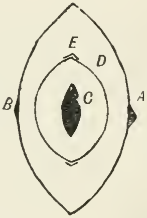


FIG. 62.—Showing the position of lenticular opacities.

A. Anterior polar cataract.
B. Posterior polar cataract.
C. Nuclear cataract.
D. Lamellar cataract with rider E.

Congenital and infantile forms are divided into :

1. Complete.
2. Partial
   - Nuclear.
   - Anterior polar.
   - Posterior polar.
   - Lamellar.
   - Hereditary dot cataract.

Complete Congenital Cataract is an ill developed opaque lens and is often so much shrunken that it consists practically only of a thickened capsule.

Partial.—*Anterior polar cataract* usually takes the form of a round white dot on the anterior capsule of the lens. It is probably due to the late formation of the anterior chamber, the prolonged contact of the lens with the back of the cornea causing the opacity.

Posterior polar cataract occurs on the posterior capsule of the lens as a round white area. It is probably due to the imperfect development of the vitreous in the cone formed by the breaking up of the hyaloid artery.

Nuclear cataract.—When the nucleus of the lens is opaque it is round in outline and situated in the centre of the lens.

Lamellar cataract is the commonest form of cataract in early life and is due to certain lamellæ of the lens being either congenitally opaque or becoming so later. It usually affects both eyes and is present at birth or develops very shortly after. When seen with the ophthalmoscope it is usually semi-translucent and just beyond the margins are seen dense markings, known as 'riders', these form the summit of the outside lamellæ which are also opaque. It practically always occurs in both eyes and is often associated with rickets, the teeth showing the typical cross line appearance associated with that disease.

Hereditary dot cataract.—Multiple dots are frequently seen in the periphery of the lenses. They rarely occur in sufficient numbers or occupy a sufficiently central position to interfere much with vision. Whole families are often affected with the disease. Occasionally these dots are of a green colour.

Symptoms.—The symptoms produced depend on the density and position of the cataract or the defect of vision caused thereby.. In the complete congenital form and in dense lamellar cataract the child may only have perception of light and it is then often associated with nystagmus. On the other hand a very thin lamellar or anterior polar cataract may cause practically no defect of vision.

In a nuclear cataract the patient may be able to see round the opacity, if small, provided the pupillary area is not entirely filled by it.

Treatment.—If the opacity does not cause serious defect of vision, that is to say less than 6/18, no treatment should be undertaken. If, on the other hand, there is an obvious defect of vision, an operation should be performed as soon as possible; that is to say, in infants of one year old. It is best to do one eye at a time. Under the age of twenty-five needling is the best operation and may require to be repeated more than once. If the lens swells much after the operation and the tension of the eye is increased, evacuation of the soft lens matter by an incision at the limbus is advisable. Shrunken lenses and dense capsules, which are sometimes left after needling, are best extracted with the aid of capsule forceps through an incision at the limbus. Occasionally, when there is a very small nuclear opacity and where good vision can be obtained by dilating the pupil, an optical iridectomy downwards and inwards may be performed without interfering with the lens at all.

Acquired Cataract.

1. Partial.	2. Complete.
Anterior polar cataract.	Senile.
Posterior polar cataract.	Toxic.
	Diabetic.
	Albuminuric.
	Due to changes in the ciliary body.

Anterior Polar Cataract is chiefly a capsular opacity and is due to the contact of the umbo or apex of the lens with the back of the inflamed cornea (Fig. 47, p. 137). It is, therefore, distinguished from the congenital form by the fact that there is always a nebula present in the cornea over it, though possibly very faint, indicating an old perforating ulcer, as is often the case following ophthalmia neonatorum. No treatment, as a rule, is required for the condition.

Posterior Polar Cataract occurs in the posterior cortex of the lens. It is usually due to defective nutrition owing to inflammatory disturbances of the ciliary body or choroid. It is, therefore, of the utmost importance to make sure of the condition of the fundus before operating on such cases. In the early stages it is distinguished from the congenital form by the fact that it is striate in appearance, whereas the congenital form, as a rule, is perfectly round and is on the capsule, and not in the substance of the lens.

Senile, Toxic and Diabetic Cataracts show no difference from each other clinically.

Ætiology.—The cause of many of the forms of cataract is at present unknown. It is probable that they may be due either to local defects of nutrition, such as cyclitis, or to some general toxic condition, as in diabetes, interfering with the nutrition of the lens. The subcortical fibres become broken up by a degenerative change, globular masses collect first within the cells, and then run together until the cortex of the lens is of a semi-fluid consistency. The sclerosed nucleus remains, and is the portion of the lens which is extracted by operation.

Cataract has been divided into four stages :—

1. Incipient, a condition in which there are striæ in the lens (Figs. 60, 61).

2. Swelling of the lens due to liquefaction of the fibres of the cortex.

3. Mature cataract in which the cortex is practically semi-fluid and the lens completely opaque.

4. Hypermature when the fluid begins to be absorbed again, and a flattened mass remains. There are no markings on the surface and often a brownish shade is seen in it. Calcareous changes may occur in it, especially if the cataract has been caused in the first instance by inflammatory disturbance.

Symptoms.—Small opacities, and opacities in the periphery of the lens, cause little or no defect of vision, but after a time the patient's sight gradually begins to fail. Spots before the eye (muscæ volitantes) and monocular polyopia (multiple vision in one eye) are complained of. If the opacity is central the patients see best in the evening when the pupil dilates; if in the periphery, the reverse. Whilst the lens is swelling the patients often become slightly myopic, and hence are able to do without glasses which they have previously worn for reading.

Senile, toxic, and diabetic cataracts show no difference from each other clinically. Occasionally in the senile form the nucleus is affected, becoming brown in colour (nuclear sclerosis). Occasionally these changes go on to such an extent as to cause a brown or black cataract. Napthalene and ergot are the two toxic causes; both are very rare.

In diabetes the cataract will sometimes clear to a slight extent under anti-diabetic treatment.

Treatment.—Cataract should be extracted when the patient's vision has failed, so that he is unable to follow his occupation satisfactorily (less than $\frac{6}{18}$ in both eyes). The following points must be examined before the operation is performed—

1. The patent must have a good perception of light in the eye.

2. The patient must have a good projection of light; that is, he must be able to locate the light in all directions when thrown into the eye from a mirror.

3. Note whether the pupils are equal and active.

4. The condition of the fundus of the other eye, if observable, should be taken into account, as many diseases, such as choroiditis and myopia, are bilateral.

5. The lachrymal sac and conjunctiva must not

be inflamed ; that is to say, there must be no discharge from the eye, the lachrymal sac is the most frequent cause of sepsis.

(For cataract operation see Chapter XII, p. 330.)

After the removal of a cataract the lens (which has been removed) must be replaced by a glass, generally by about + 11 for distance in a previously emmetropic person. There is usually also some astigmatism, about 2 dioptres, with the axis in the same direction as the incision. A +4 sphere must be added to the distance glasses for purposes of reading.

Displacements of the Lens.—These may be *congenital* or *acquired*, *partial* (luxation), or *complete.*

Congenital Dislocation of the lens may occur in several members of the same family. It is usually bilateral, the dislocation being in an upward direction (Fig. 63).

The acquired form is usually the result of a blow. In both congenital and acquired forms there is a defect in the suspensory ligament on the opposite side to that in which the lens is dislocated.

Complete dislocation may take place (1) backwards into the vitreous, and (2) forwards into the anterior chamber.

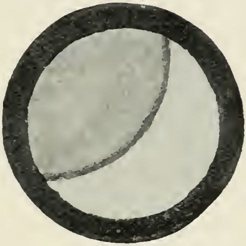


FIG. 63.—Congenital dislocation of the lens upwards and outwards.

Symptoms.—*In luxation* the eye becomes myopic owing to the relaxation of the suspensory ligament, the lens becoming more rounded in shape. Monocular diplopia is caused when the lens half covers the pupil, so that the patient can see through and round the edge of the lens.

Complete dislocation backwards leads to high hypermetropia as in an aphakic eye (an eye without a lens), and the dislocated lens is liable by its movement up and down to set up a quiet cyclitis and retinal detachment. It can usually be seen by the ophthalmoscope floating about in the vitreous.

Complete dislocation forwards into the anterior chamber sets up spasm of the sphincter of the iris, which prevents it from returning. The grey lens is seen in the anterior chamber. There is usually considerable pain and ciliary injection, the tension of the eye often being raised. The condition has to be distinguished from blood staining of the cornea; the latter is, however, of rare occurrence.

Treatment.—If the lens is not causing irritation, glasses may be ordered to improve the vision. If, on the other hand, irritation is caused by the dislocated lens it must be extracted. This should nearly always be performed if the lens is in the anterior chamber. It should be extracted in its capsule as needling of a dislocated loose lens is impracticable. Blind glaucomatous eyes with a dislocated lens are best enucleated.

Lenticonus is a rare congenital or acquired anomaly in which the lens presents a conical prominence on its posterior surface, rarely on the anterior. It is recognized by the distortion of the fundus it produces when seen with the ophthalmoscope. Care must be taken to distinguish it from conical cornea and sclerosis of the nucleus of the lens which also cause distortion of the fundus image, easily recognizable conditions on focal illumination. Vision may be improved with glasses. In rare cases in which the vision is very bad and cannot be improved, needling or extraction may be necessary.

CHAPTER VII

DISEASES OF THE RETINA, VITREOUS AND OPTIC NERVE

The retina in life is a thin translucent membrane of a purplish colour (visual purple) which is rapidly bleached by light, and after death becomes opaque. Similarly, pathological changes cause opacity in it so that minute differences are readily detected with the ophthalmoscope. The retina is primarily attached to the globe at the papilla of the optic nerve and at the ora serrata. Elsewhere it is easily separable from the choroid. Changes in the vitreous, such as shrinking, may thus give rise to detachment. Directly outwards, 3 mm. from the optic papilla, can be seen a yellow spot—the fovea centralis—and upon the integrity of this area depends the acuity of vision, since if this area be not involved central vision will remain good, in spite of the existence of disease in all other parts of the retina.

The layers of the retina from within outwards are—

1. Internal limiting membrane.
2. Layer of nerve fibres.
3. Layer of ganglion cells.
4. Internal molecular layer.
5. Internal nuclear layer.
6. External molecular layer.
7. External nuclear layer.
8. External limiting membrane.
9. Layer of rods and cones.
10. Layer of pigment cells.
11. Membrane of Bruch (usually described with the choroid).

For details of histology text books on physiology should be consulted.

The Blood Vessels are derived from the central artery and vein of the retina. They only penetrate to the internal nuclear layer—a point which is of considerable importance in helping to determine the position of an exudation. The outer layers are entirely dependent on the choroid for nutrition.

Congenital Abnormalities — Opaque Nerve Fibres (medullated) (Fig. 64) are usually seen at the disc margins as white patches, flail like in shape, the retinal vessels being partially buried in them. More rarely they occur away from the disc. The field is defective, corresponding to the area of retina

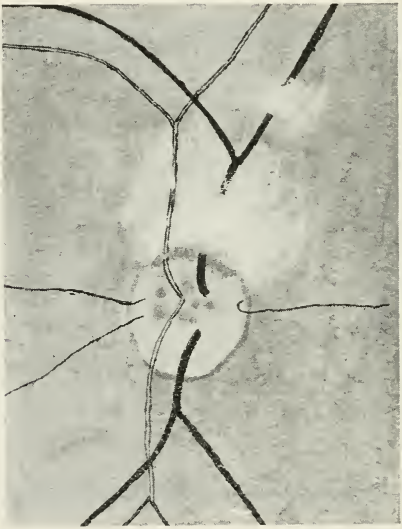


Fig. 64.—Opaque (medullated) nerve fibres.

they cover. The medullary sheath of the nerve fibres in these cases is not continuous through the lamina cribrosa, being always absent in that region.

Congenital Night Blindness is an hereditary disease in which the patient cannot see in the dusk. No cause is at present known, and the fundus presents no change.

Injuries.—Blows on the globe may cause an intense œdema in the macular region (commotio retinæ). This œdema may be so great as to cause the retina to give way and a hole to appear.

Holes in the retina, apart from injury, occur at the macula associated with *amaurotic family idiocy*; elsewhere in cases of detachment of the retina due to retinal œdema. They appear as a bright red area (choroidal reflex) seen in contrast with the whitish opaque retina.

Symptoms.—There is a loss of sight in the eye affected. The vitreous is frequently so full of blood that no details of the fundus can be seen. In slight cases the macular region may appear whitish in colour, and the retinal vessels are often slightly raised over this area. There may be retinal hæmorrhages about the macula.

Prognosis and Treatment.—If only a mild degree of œdema is produced (commotio retinæ), a good prognosis may be given. If severe, or if there be a hole at the macula, a bad prognosis should be given. The treatment consists in the application of a pad and bandage. Atropine should be used if ciliary injection is present.

Eclipse, or Sun Blindness is usually the result of staring directly at the sun. It is characterized by a central scotoma in the field of vision, which may remain permanent. When first seen in the early stages some retinal œdema in the macular region may be present. Often no ophthalmoscopic changes are observable.

Treatment consists in complete rest in a dark room, followed by the wearing of dark glasses. If improvement does not take place within the first few days a complete recovery is unlikely, and a permanent central scotoma remains.

Diseases of the Retina depending on Vascular Degenerations.—General Considerations.

Under the old nomenclature there was a tendency to ascribe all diseases, of which the pathology was not known, to inflammation. Hence the terms applied to the following diseases, which are not, strictly speaking, of inflammatory origin at all.

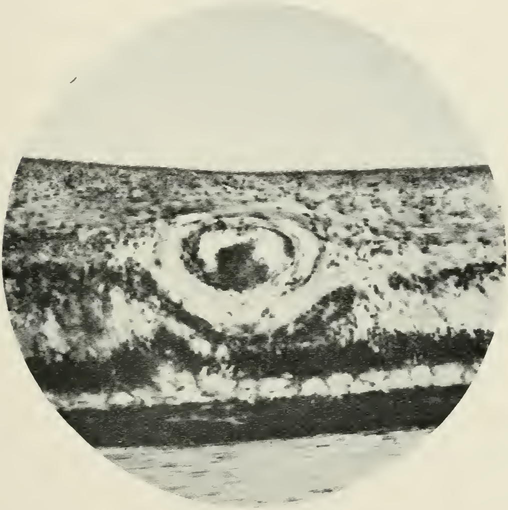


FIG. 65.—Arterio-sclerosis in a retinal vessel (silver wire arteries); note the thickening of the vessel's coats.

The blood vessels within the globe seem very liable to undergo degenerative changes, both as the result of local changes such as follow inflammation, and as the result of general changes in the vascular system (sclerosis) (Fig. 65). Too much importance cannot be attached to their routine examination in cases of suspected vascular sclerosis, as it is the only position in the body where the blood vessels come under direct ocular observation. The chief signs of vascular sclerosis of the ocular vessels are—

Retinal.—1. White lines along the course of the arteries (Plate IV).

2. Kinking and diminution in the calibre or partial obliteration of the veins where they are crossed by the arteries.

3. Tortuosity of the vessels.

4. Thrombosis of the artery or veins.

5. Pigmentary disturbances.

Choroidal.—1. White lines along the choroidal vessels, which may be transformed into white worm-like streaks containing practically no blood.

2. Pigmentary disturbances, which are usually produced by the formation of *colloid nodules* on the membrane of Bruch, most commonly seen in the macular region as small round white areas, and are then known as senile or *Tay's choroiditis.*

Thrombosis and Embolism of the Central Artery of the Retina.—The central artery of the retina, like the cerebral arteries, is an end artery; that is to say, a block in its course renders the retina functionless, the anastomosis which is present at the nerve head, known as the circle of Zinn, being insufficient to prevent functional death of the retina, although sufficient to fill the blood vessels after a few hours. The block usually occurs just behind the lamina cribrosa.

Symptoms.—If due to thrombosis following end-arteritis there are often premonitory symptoms, such as sudden failure of sight, lasting from a few minutes to an hour, probably due to arterial spasm, and there are signs of vascular sclerosis in the other eye and elsewhere. In true embolism the onset is sudden. The vision is lost completely and does not return.[1] Clinically during the first twenty-four hours the appearance is characteristic. The fundus is blanched, due to loss of transparency of the retina, the macula appearing as a cherry-red spot owing to the contrast of the red choroid being seen more easily through the thin retina of that region. The arteries are reduced to mere threads ; gradually as the collateral circulation is established the colour returns to the fundus, and there may be a bead-like appearance of the blood in the vessels. The disc becomes atrophic, and the retinal vessels remain very small. In true embolism, heart disease is usually present. Thrombosis of the central artery may also follow as a sequel to thrombosis in the central vein resulting from stagnation.

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[1] If a cilio-retinal artery be present vision is retained in the area supplied by it.

Treatment.—If seen during the first twenty-four hours an attempt may be made to drive on the clot by performing paracentesis of the anterior chamber, with a gentle massage of the globe, but unfortunately there is not much hope of success.

Thrombosis of the Central Veins (Fig. 66), occurs after occlusion of the lumen (1) from vascular sclerosis, and (2) from inflammation of the optic nerve and retina (neuro-retinitis). Of these the first cause is by far the more common. A factor which plays an important part is that the intra-ocular pressure is equal to or greater than the pressure in the veins at their exit from the globe through the optic disc, which is evidenced by the pulsation so often seen at this spot. The block in

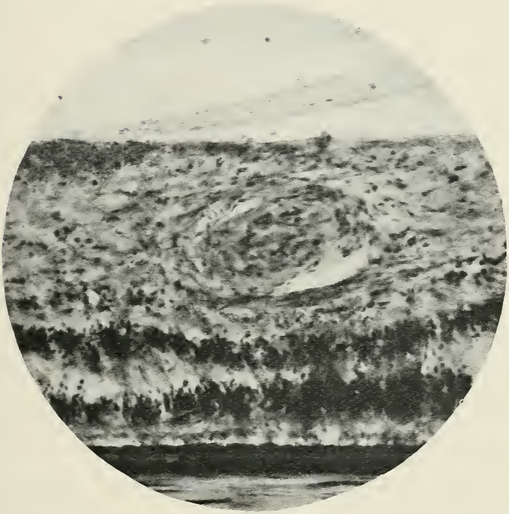


FIG. 66.—Thrombosis in a retinal vein following arterio-sclerosis. The patient subsequently developed glaucoma.

the vein usually occurs behind the lamina cribrosa, although one of the branches is by no means infrequently affected. Once the block has occurred the following sequelæ may result, and have been observed—

1. Canalization of the clot.
2. Anastomosis round the site of the thrombosis.
3. Secondary thrombosis in the central artery from stagnation.

The condition is very liable to be followed later by glaucoma.

Symptoms.—The patient complains of sudden loss of sight in the eye. If the whole vein is completely blocked there is bare perception of light ; if a branch, some vision is maintained. On examination the vein is seen to be enormously engorged with blood and the whole fundus becomes covered with large hæmorrhages. The optic disc is swollen, and the edge is blurred. The arteries usually show signs of vascular sclerosis.

Prognosis.—If the main vein is blocked the prognosis is bad ; if only a branch, a fair amount of vision may be restored.

Treatment.—Locally, beyond protection from the light and perhaps leeching, little can be done, but every effort should be made to treat the general condition (albuminuria, etc.) which has led to the vascular change. Citric acid may be given to lower the coagulability of the blood.

Cavernous Sinus Thrombosis is usually the result of some septic changes in the orbit or spreads from one of the other cerebral sinuses. In acute cases it leads to intense proptosis with engorgement of the veins, and in chronic cases to much the same ocular changes in both eyes as have been described in thrombosis of the central vein, although the hæmorrhages are not so numerous. The prognosis to life is on the whole bad, and depends on the cause of the thrombosis and the possibility of relieving it by operative measures.

Albuminuric Retinitis is a condition which shows that renal disease is affecting the ocular vessels; this has already been described under vascular sclerosis and thrombosis (Plate IV).

The disease occurs with all forms of renal disease, but the prognosis to life differs widely. Thus when associated with puerperal albuminuria the patient may make a good recovery and remain well. On the other hand, when associated with a small granular or large white kidney, the patients seldom live beyond two years.

Symptoms.—It may or may not cause failure of sight. There is intense œdema of the nerve head (optic neuritis) and retina, as shown by the white patches of exudation (Fig. 67). In the macular region these often take the form of a star-shaped figure (Plate IV and Fig. 68). Some of the patches have soft edges and are of recent date. Other

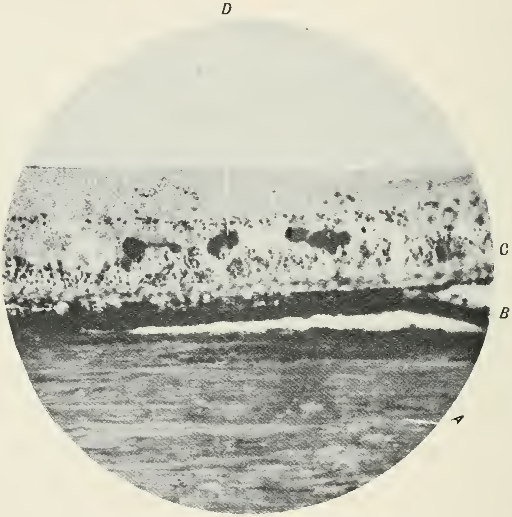


Fig. 67.—Albuminuric Retinitis showing the albuminous coagulum (white patches) in the layers of the retina.

A. Sclerotic.
B. Choroid.
C. Retina.
D. Albuminous coagulum (œdema).

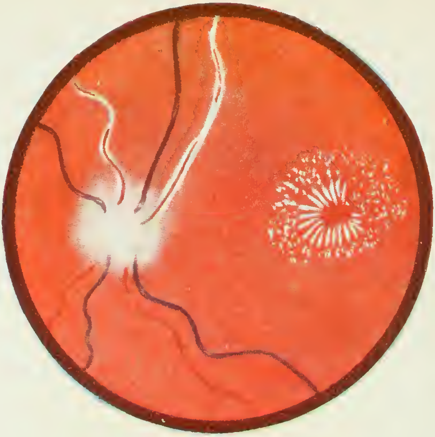


FIG. 1.—ALBUMINURIC RETINITIS (LATE STAGE).

The disc is in a condition of post-neuritic atrophy, the superior arteries are thrombosed, the lower show arterial sclerosis. The star figure (oedema) is present at the macula.

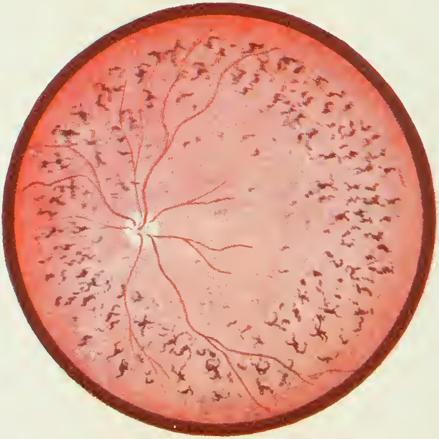


FIG. 2.—RETINITIS PIGMENTOSA.

Note the small size of the arteries, the atrophic disc, the absence of white areas, the peripheral distribution and fine character of the pigmentation. (Compare with Plate III., Fig. 1.)

To face page 221.] [*Plate IV.*

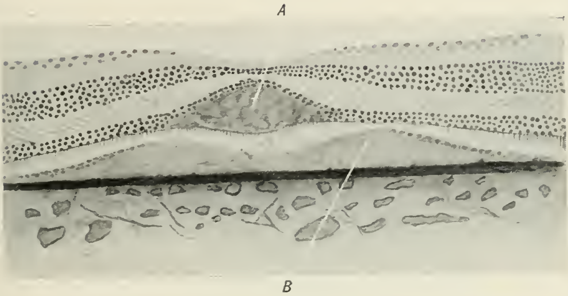


Fig. 68.—Section through the macula lutea in a case of albuminuric retinitis in which the star figure was present, showing the position of the exudation intra- (*A*), and sub-retinal (*B*).

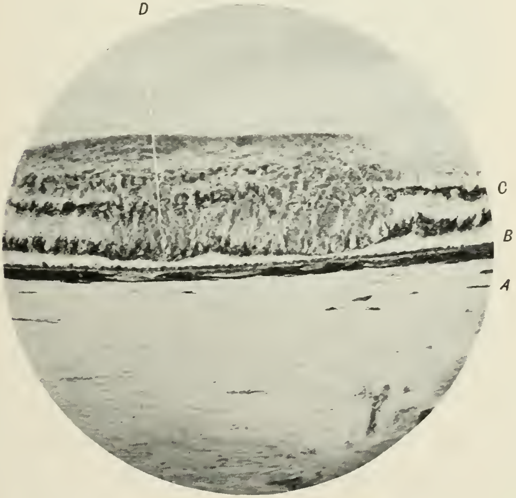


Fig. 69.—Intra-retinal hæmorrhage—albuminuric retinitis—showing the destruction of the retina caused thereby.

A. Sclerotic.
B. Choroid.
C. Retina.
D. Hæmorrhage.

sharply defined patches are remains of old exudations.

Hæmorrhages into the retina are usually present. Their position is of importance, as if occurring in the substance of the retina they cause destruction of its elements (Fig. 69); whilst if occurring superficially (subhyaloid) they may be absorbed without causing any defect in vision at all. Subhyaloid hæmorrhage can be distinguished by the fact that it is very large, and is usually half moon shaped,

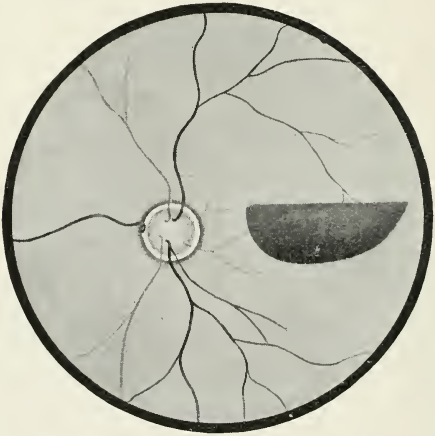


Fig. 70.—Subhyaloid hæmorrhage.

Note the boat-shaped appearance due to the separation of the hyaloid membrane of the vitreous from the retina, the blood sinking to the lower part.

the curved edge occupying the lowest part (Figs. 70 and 71). Hæmorrhages into the nerve fibre layer have usually a striped flame-shaped appearance.

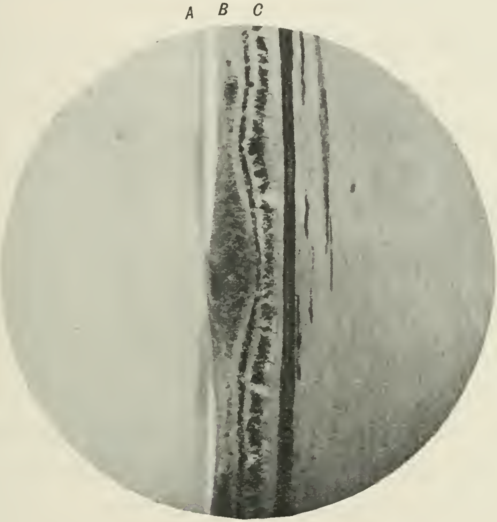


FIG. 71.—*Subhyaloid hæmorrhage* showing the comparatively slight changes caused in the retina thereby.

A. Hyaloid membrane.
B. Hæmorrhage; the blood has accumulated at the most dependent part.
C. Retina showing comparatively little change.

Circular hæmorrhages are usually in the deeper layers.

Diabetic Retinitis may have the same ophthalmoscopic appearance as that due to albuminuria.

More frequently the hæmorrhages and white patches are small and punctate in the macular region, and not infrequently a central scotoma is present in the field of vision.

Leucæmia and General Septic Diseases (e.g. pyæmia) may give rise to similar retinal changes.

The treatment depends on the causal lesion.

Retinitis Pigmentosa (Plate IV)—**Pathology.**—Retinitis pigmentosa is a disease which is caused by local sclerosis of the retinal and ciliary vessels, resulting in atrophy of the retina and optic nerve. The atrophy is followed by pigmentation, due to the proliferation and migration of the pigment epithelium. Occasionally this pigmentation is absent (retinitis pigmentosa albescens). The disease is bilateral and commences in childhood, and may be associated with other congenital abnormalities, such as deaf mutism.

It is usually hereditary, many members of the same family being affected ; a history of consanguinity is often present. Patients suffering from the disease complain of night blindness and gradual failure of sight, which is due to a gradual contraction of the fields, island, or ring scotomata often being left.

Clinically the disc is atrophic and the retinal vessels often extremely small. The fundus is dotted over with innumerable small areas of dark pigment, which are most marked in the periphery. The pigmentation assumes a shape similar to that of the Haversian canals found in bone. The peripheral distribution, the fine branching of the pigmentation, and the absence of white areas further serve to distinguish it from choroiditis. The choroidal vessels often show marked sclerosis. As the disease progresses the nutrition of the lens is often affected resulting in a posterior polar cataract.

Treatment.—The administration of nitro-glycerine and nitrite of amyl, as also the use of the galvanic current locally, may all cause temporary improvement, but the prognosis is unfavourable, the disease ending in blindness in the course of years.

RETINAL DEGENERATION ASSOCIATED WITH CEREBRAL DEGENERATION.

Amaurotic family idiocy.—The disease usually occurs in children under three years of age, especially in Jews, and always ends in the death of the patient. The appearance of the fundus, which is an early sign, is characteristic and has been described under "Holes in the Retina" (*see* p. 211).

Cerebral degeneration associated with a stippled condition in the macular region also occurs in older children from about six to twelve years. The children become dull at school—there is a central scotoma in the fields which often leads the patient to walk with the head turned to one side. The patients usually become imbeciles. The disease runs in families, a history of consanguinity and syphilis in the parents being often obtained.

Inflammation of the Retina.—**Retinitis.**—Acute septic inflammation of the retina takes place as part of general panophthalmitis.

Syphilitic Retinitis is usually associated with inflammation of the choroid (choroido-retinitis), or with inflammation of the nerve (neuro-retinitis).

Symptoms.—The patients generally seek advice on account of failure of vision. On examination with the ophthalmoscope in the early stage there is a diffuse cloudiness of the retina, somewhat resembling the bloom on fruit. The retinal vessels are engorged, and may be partly buried in exudation. The optic disc is in a condition of neuritis. Vitreous opacities are frequently present. Later, pigmentary changes follow.

Prognosis.—Gradual improvement usually takes place under treatment. The disease takes months to settle down, and is often followed by retinal pigmentation. The central vision usually recovers provided the macula is not badly affected.

Treatment.—The lesion is a late secondary affection. Mercury should be administered as rapidly as possible followed by a course of iodide of potassium. The eye in the early stages should be protected from light by confinement to a darkened room. Later, dark glasses may be worn.

Detachment of the Retina. (Plate V)—**Causes.**—The chief are—

1. A blow on the eye.
2. High myopia.
3. New growth in the choroid.
4. Shrinking or loss of vitreous, following retino-choroiditis or injury.

More rarely hæmorrhage from the choroid after operations, such as for glaucoma, may lead to an active propulsion of the retina.

Symptoms.—Loss of vision over the detached area. The patients complain of a cloud corresponding to the position of the detachment. If the retina is completely detached, blindness ensues. The history of a blow, or of previous short sight, or the presence of signs of an old irido-cyclitis or retino-choroiditis, will usually help to distinguish the condition from a new growth in the choroid—the chief characteristics of which have already been given. (*See* New Growths in Choroid, p. 189.)

With the ophthalmoscope the appearance varies, according to whether the retina is partially or completely detached. If partially, the detachment may be white in colour, owing to the opalescent fluid behind, or may appear red if the fluid behind be clear, allowing the reflex of the choroid to be seen through it.

The retinal vessels as they pass on to the detachment appear bent and tortuous. The vessels passing over the detachment may be seen by the direct method, and need a higher + glass than the rest of the fundus. Folds, holes, and cysts in the retina are not uncommon. The detachment can often be seen by focal illumination, if complete, the white retina floating up and down behind the pupil.

Treatment.—If due to a blow or high myopia, an attempt should be made to promote absorption of the fluid causing the detachment. The patient should be put to bed and kept absolutely at rest, the head on no account to be raised from the pillow. A pressure bandage should be applied and pilocarpin administered. The fluid may be evacuated by a puncture through the sclerotic, but on the whole the prognosis is not good, since, even if improvement takes place temporarily, a relapse is very liable to occur.

New Growths.—**Glioma of the Retina** is a malignant growth occurring in young children usually before the age of three and never later than the tenth year. The disease starts in the nuclear layers of the retina from the supporting structures. If it grows from the outer layer, the remainder of the retina and the retinal vessels are pushed inwards and can be seen ophthalmoscopically (glioma exophytum); if from the inner nuclear layers it fungates inwards (glioma endophytum). The glioma continuing to grow pushes forwards the lens and iris, obliterating the anterior chamber. Subsequently the growth spreads backwards along the course of the optic nerve, and thence into the orbit and brain, and so causes death (Fig. 72).

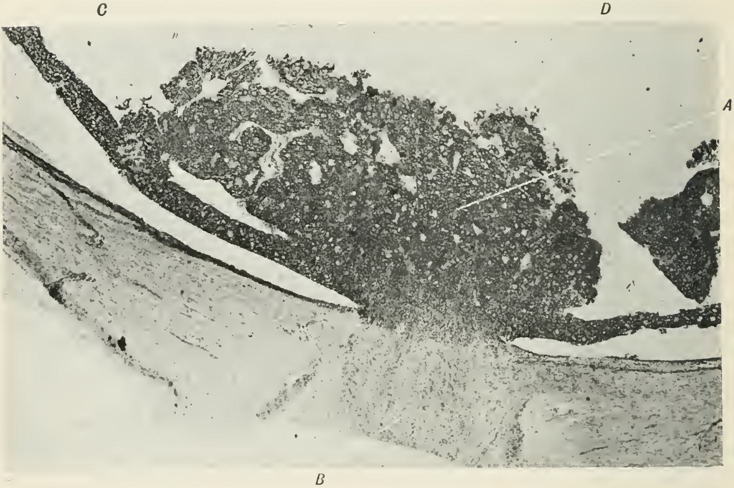


FIG. 72.—Glioma of the retina *A* commencing to involve the optic nerve *B*.

The glioma growing from the nuclear layers of the retina *C* has converted it into a mass of new growth. The portion of the growth *A* is fungating into the vitreous *D*.

Glioma, as a rule, attacks only one eye, but occasionally the other may develop the same disease. This is quite a separate growth from that in the first eye, which may have been removed early.

Symptoms.—The patient is usually brought by the mother who has noticed a greenish-white reflex behind the pupil, which she may describe as resembling a cat's-eye. The anterior chamber may be shallow, the iris pushed forward and the pupil dilated. The tension may be raised or lowered. As a rule there is no ciliary injection—a point which may help in distinguishing it from pseudoglioma. The retinal or new vessels may or may not be seen on the surface of the growth. In the earliest stage the disease may be seen as a small, white, sharply-defined area in the fundus. As the disease progresses the globe becomes filled with growth, which then spreads backwards along the optic nerve and into the orbital tissue and may finally end by invading the brain. In the later stages it causes symptoms similar to those of an orbital tumour (see p. 319).

Diagnosis.—The diagnosis from pseudo-glioma, a condition due to a mass of fibrous tissue behind the lens of either inflammatory or congenital origin, is often impossible without removing the eye, and this should be done in all cases of doubt.

The chief points in favour of glioma are that:—(*a*) the reflex is whiter in colour; (*b*) iritic adhesions are absent; (*c*) the tension is usually either normal or raised, whilst in pseudo-glioma it is decreased.

Treatment.—If the growth is confined to the globe, this consists in enucleation of the eye, the optic nerve being cut far back. If the growth has spread beyond the globe, evisceration of the orbit should be performed. The prognosis is favourable, provided the growth has not extended beyond the globe. A careful watch should subsequently be kept on the other eye in case the disease should start in it; if this takes place it should also be enucleated.

DISEASES OF THE VITREOUS.

The vitreous is a connective tissue of a very loose structure, having a semi-fluid consistency; it contains no blood vessels, its nutrition being carried on by lymph derived principally from the ciliary blood vessels. It contains one main lymph channel, the hyaloid canal, which passes from the back of the lens to the optic disc in the situation of the hyaloid artery during fœtal life.

Congenital Abnormalities.—*Persistent Hyaloid Artery.*—The artery may remain either as a patent vessel or more commonly as a fine fibrous thread passing from the optic disc to the back of the lens. The interference with vision depends on the amount of artery persisting.

Atypical development of the vitreous may lead to *fibrous bands,* usually passing from the disc forward to the ciliary body, or *connective tissue films,* which often cover the optic disc like a veil.

Inflammation.—Inflammatory exudation from the ciliary body may take place into the vitreous and the exudate is seen ophthalmoscopically as opacities floating upwards and downwards when the eye is moved. As organization takes place in the exudate it leads to *shrinking of the vitreous* which may subsequently end in *detachment of the retina.*

Vitreous Hæmorrhage.—Recurrent hæmorrhage into the vitreous is an affection of young people, usually men, and is not infrequently associated with nose bleeding.

Symptoms.—The patients lose their sight suddenly, and sometimes complain of seeing all objects red. After a time the blood may be absorbed, leaving good vision, often to be followed by another attack. The blood can be seen in the vitreous by focal illumination, and no red reflex can be obtained with the ophthalmoscope. After a time a certain amount of organization may take place, leading to fibrous bands in the vitreous (*retinitis proliferans*) and cholesterin crystals. Subsequently detachment of the retina may follow caused by contraction of the bands. The blood may come from either the ciliary or the retinal vessels.

Treatment.—The condition is associated with a high coagulability of the blood and possible thrombosis. Citric acid, therefore, is best administered. Some cases have been treated by injections of antihæmolysins into the vitreous. In cases where there are premonitory symptoms, such as temporary failure of sight, it is advisable to bleed the patient before the onset.

DISEASES OF THE OPTIC NERVE.

Anatomy.—The optic nerve is an "inter-central" nerve collecting its fibres from the retina and terminating in the chiasma. It is divided into three parts :—

1. Intra-ocular.
2. Intra-orbital.
3. Intra-cranial.

1. **The intra-ocular** is the only portion of the optic nerve which can be examined with the ophthalmoscope and may be seen as the optic disc. The nerve fibres in this position are non-medullated, the medullary sheaths ceasing on the outer side at the lamina cribrosa, the outline of which can be seen with the ophthalmoscope through the translucent nerve fibres in the disc as a darkish mottling. This becomes more apparent in primary optic atrophy.

The fibres which come from the macular region lie to the temporal side of the nerve.

2. The **Intra-orbital** portion of the optic nerve

describes an S-shaped bend in its course from the eye to the optic foramen in order to allow free movement of the globe. In cases of pronounced proptosis the movements of the globe are therefore limited, owing to the nerve being put on the stretch.

The intra-orbital portion of the nerve is covered by a sheath continuous with the membranes of the brain. It is easy to see, therefore, than any increase of intra-cranial pressure will force fluid down the nerve sheath and cause pressure on the nerve as it passes through the rigid foramen of the sclerotic, and so cause intense œdema of the nerve head, due to pressure on the retinal vessels (optic neuritis)—a condition known as choked disc, and frequently associated with cerebral tumours.

3. The **Intra-cranial** portion of the nerve extends from the foramen to the chiasma. It is this portion of the nerve which is liable to be affected by periostitis of the orbit and tumours of the bone.

Complete division of the nerve causes blindness of the eye affected (Fig. 73).

At the **chiasma** there is a semi-decussation of the nerve fibres. The fibres from the outer half of each

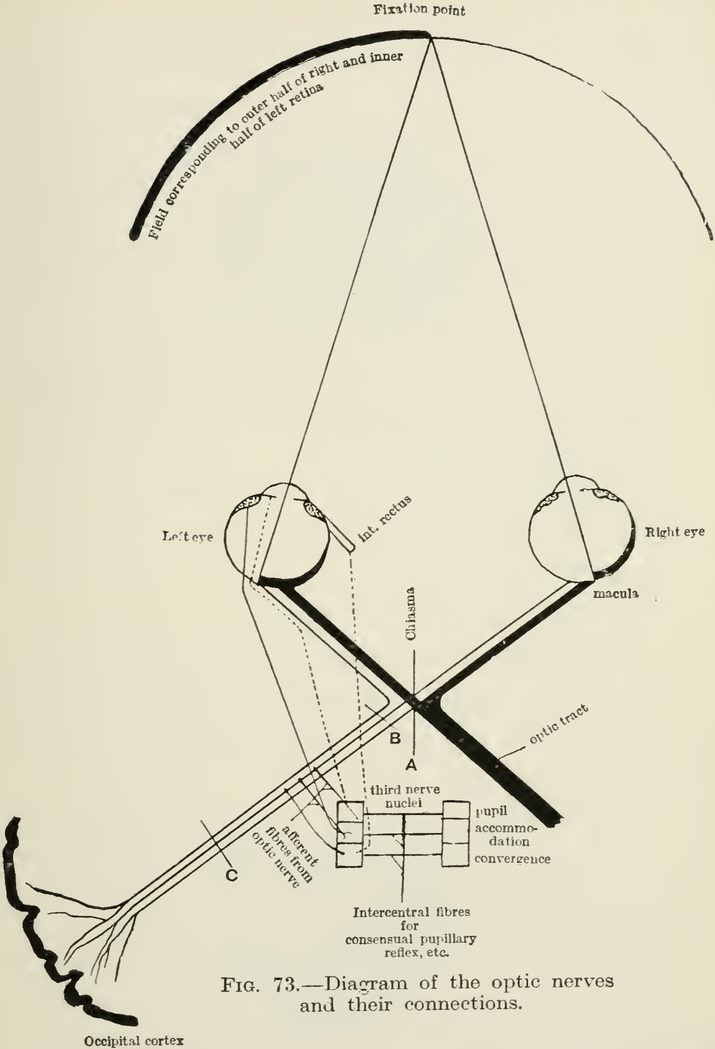

Fixation point
Field corresponding to outer half of right and inner half of left retina
Left eye
int. rectus
Right eye
macula
Chiasma
optic tract
B
A
third nerve nuclei
pupil
accommodation
convergence
afferent fibres from optic nerve
C
Intercentral fibres for consensual pupillary reflex, etc.
Occipital cortex

FIG. 73.—Diagram of the optic nerves and their connections.

A lesion at *A* causes bi-temporal hemianopia; a lesion at *B*, homonymous hemianopia, with hemianopic pupil reaction; a lesion at *C*, homonymous hemianopia, with reaction of the pupil to light.

retina (nasal half of the field) pass to the brain on the same side, whilst the fibres from the inner half of each retina (temporal half of the field) decussate and pass to the opposite side. Fibres derived from the macular region go to both sides (Fig. 74).

Lesions—If the central portion of the chiasma is affected, loss of the outer halves of both fields (bi-temporal hemianopia) is the result. The most common causes of such lesions are tumours of the pituitary body, especially acromegaly ; diseases of the sphenoidal sinus, and fracture of the base of the skull (Fig. 73, *A*, and Fig. 74).

The Optic Tract is formed by the fibres derived from the outer half of one retina and the inner half of the other, the latter having decussated at the chiasma (Fig. 75).

Lesions.—Complete division of the tract, therefore, leads to the loss of the temporal half of one field and the nasal half of the other (homonymous hemianopia), the nasal half of the field belonging to the same side as the tract affected. Patients with this lesion are unable to see objects to one side

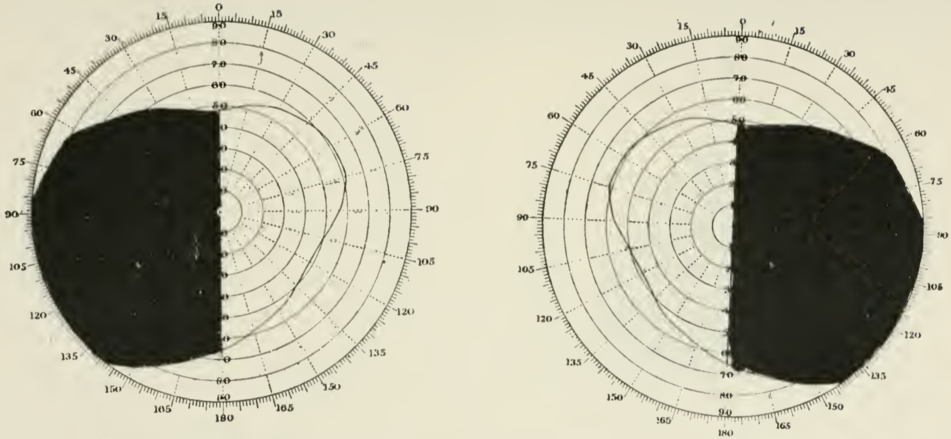


FIG. 74.—Bi-temporal hemianopia, from a case of acromegaly due to pressure on the central portion of the chiasma.

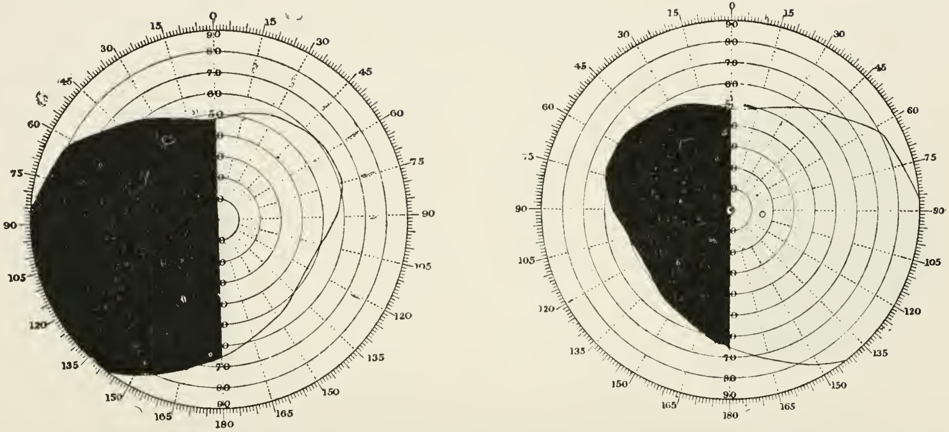


FIG. 75.—Homonymous hemianopia, from a case of a lesion of the left optic tract following a fracture of the base of the skull.

of them ; one of the commonest causes of such an affection is a fracture of the base of the skull (Fig. 73, *B*, and Fig. 75).

Cerebral Distribution.—Fibres from the tracts pass backwards to the external geniculate bodies and corpora quadrigemina giving off in this region fibres which communicate with the third nerve nucleus for the light reflex of the pupil. Lesions, therefore, above this area cause no alteration in the light reflex (Fig. 73, *C*). In the case of homonymous hemianopia, when light is thrown carefully on to the blind side no reaction of the pupil of this side will take place if the lesion is in the tract (hemianopic pupil reaction). Careful shielding of the sclerotic with the finger is necessary in testing the inner half of the retina as the light through the sclerotic on the outer side is sufficient to cause reaction. The fibres pass round the optic thalamus and thence upwards to the occipital cortex, via the optic radiation of the internal capsule.

Congenital Abnormalities.—**Coloboma of the nerve sheath** (Fuchs' coloboma) is due to imperfect closure in the fœtal ocular cleft. It is of fairly common occurrence, and the retinal vessels emerge from the upper part of the disc while the lower part appears as a whitish semilunar area (Fig. 76). *Crater like holes and total ectasia* of the disc are rare congenital abnormalities.

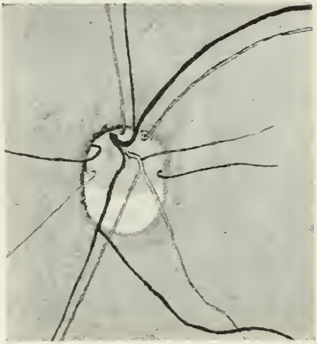


FIG. 76.—Fuchs' coloboma of the optic nerve. The vessels appear to come out of the upper part of the disc. There is a congenital crescent below.

Congenital Blindness, due to defects in the nerve, may arise from several causes :—

1. Mal-development of the skull (e.g. oxycephaly or tower skull).

2. Mal-development of the brain (e.g. cerebral cysts of the occipital lobe).

3. Intra-uterine inflammatory changes or maldevelopment of the optic nerve.

Ophthalmoscopically there is often little to be seen at the disc, which may or may not be grey in colour.

Injuries.—Gunshot wounds, stabs and fractures of the base of the skull are the commonest causes of injury to the optic nerve. They may give rise to an actual division of the nerve or hæmorrhage into the sheath. In both instances there is a loss of sight. If due to hæmorrhage into the nerve sheath, partial recovery may take place. If the lesion is behind the entrance of the retinal vessels into the nerve there is no change to be seen at first but subsequently a descending optic atrophy appears at the disc. If the retinal vessels are divided the appearance of the fundus resembles that associated with embolism of the central artery of the retina. The optic nerve, being an intercentral nerve, does not regenerate.

Inflammation.—**Optic neuritis** may take place: (1) within the globe; (2) behind the globe (retrobulbar neuritis).

1. **Intra-ocular neuritis** is of two types :—

(*a*) *Engorgement and œdema* such as are seen in the case of choked discs associated with cerebral tumours and in cases of neuritis associated with albuminuria (Plates III and IV).

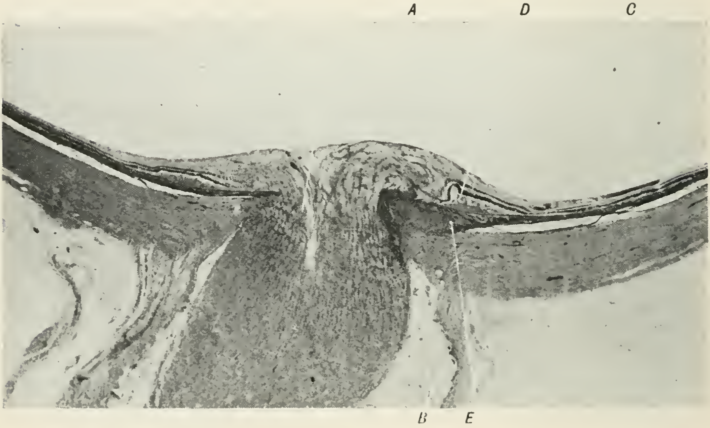


FIG. 77.—Optic neuritis.

A. Swollen œdematous nerve head.
B. Distended nerve sheath.
C. Retinal hæmorrhage.
D. Subretinal œdema.
E. Mass of tubercle involving the nerve pressing on the retinal vessels *F.*

(*b*) *Direct transmission of true inflammatory changes in the nerve*, the chief causes of which are :—

(1) Syphilis and tubercle ; (2) acute febrile dis-

eases ; (3) chronic poisoning, such as lead ; (4) acute anæmia, as after hæmatemesis ; (5) orbital inflammation ; (6) meningitis (Fig. 77).

It is probable that the latter is due more to distension of the sheath owing to increased intracranial tension, than to the direct spread of the inflammation.

Symptoms.—In the early stages of engorgement neuritis there may be little or no symptoms, and it is often only discovered in the routine examination of the patient, one of the chief characteristics being good vision associated with a large amount of ophthalmoscopic change. Later, failure of sight may make itself evident; the only exception to this being in the cases where degeneration of the vessels has led to their occlusion, when there is a history of sudden loss of vision. In true inflammatory changes there is usually a rapid and often complete loss of vision. In both syphilis and tubercle the retina and choroid often participate in the affection.

On ophthalmoscopic examination of the disc the following points are noted :—

The colour of the papilla is red or reddish grey or it is mottled with extravasated blood.

The outline of the disc is lost, the exudate extending into the surrounding retina in streaks.

The veins are enormously engorged and tortuous, being frequently buried in the exudate near the disc. The arteries are usually small.

The swelling of the papilla is perhaps the most important of all. It is measured by comparing the focus of a vessel on the top of the disc with that of the surrounding retina, and the swelling is expressed in dioptres. 3 D = 1 mm. of swelling. The presence of swelling excludes the condition known as hypermetropic disc, which in other respects often similates optic neuritis.

Treatment consists in attending to the general disease which is the original cause of the neuritis. Dark glasses should be worn. In cases of cerebral tumour, trephining in order to reduce the intracranial pressure will often relieve the neuritis and so save the sight of the patient.

2. **Retro-bulbar Neuritis** is an interstitial inflammation of the nerve behind the entrance of the

retinal vessels. Hence in the early stages no changes are seen in the disc, though later they may become apparent owing to development of atrophy (descending atrophy).

Symptoms.—The onset is often very acute, the patients suddenly losing their sight in the course of a few minutes. This loss of sight may be complete, or, as is more usual, may affect only the macular fibres ; that is to say, patients are not able to see objects when looking straight at them (central scotoma) (Fig. 78). As a rule one eye only is affected. Occasionally there is a history of exposure to cold, but often no history at all can be obtained.

There is tenderness to backward pressure on the eye in the early stages.

Diagnosis.—The other conditions which lead to a central scotoma in the field without ophthalmoscopic changes are :—

1. Toxic amblyopia ; tobacco, alcohol, etc.
2. Disseminated sclerosis.
3. Eclipse blindness.
4. Leber's hereditary optic atrophy.
5. Pressure of tumours and inflammatory exuda-

tion about the optic nerve in the situation of the optic foramen.

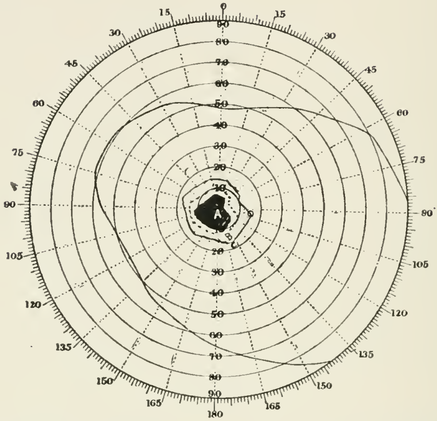


FIG. 78.—Central scotoma in a case of retro-bulbar neuritis.

A. For white.
B. For red.
C. For green.

In *toxic amblyopia* the patients are usually middle-aged. The scotoma is very small or can only be made out for colours. There is a history of the use of tobacco, lead, etc. Both eyes are, as a rule, affected equally, and recovery is usually complete on abandoning the use of the poison unless it be of long standing.

In *disseminated sclerosis* the patients are young, the scotoma is small, and recovery from the primary attacks often good. Recurrent attacks in both eyes are frequent, and may finally lead to optic atrophy. There may or may not be other signs of disseminated sclerosis.

In *hereditary optic atrophy* (Leber) the patients are young, fifteen to thirty years of age ; there is also a history of other members of the family being affected. In the early stages the disc may show some signs of neuritis. Recovery of vision may take place—the disc remaining atrophic. The disease is more liable to be mistaken for toxic amblyopia.

The *pressure of tumours* or periostitis round the optic foramen may be associated with some proptosis.

When blindness is complete it has to be diagnosed from *hysteria*, and by far the most useful sign is the sluggish or complete failure of reaction of the pupil to light on the side affected. The other tests for malingering should be applied (*see* page 252).

Treatment.—The treatment consists in protecting the eye from light and the administration of gradually increasing doses of strychnine, starting with 6 minim doses up to 15 minims three times a day. Recovery usually takes place to a certain extent and full vision may be obtained, but, in cases where vision has been completely lost, recovery as a rule is only partial if it does not take place in the first few days.

Toxic Amblyopia.—This disease, strictly speaking, should belong to diseases of the retina. It is probably due to the action of the poison on the ganglion cells in the region of the macula lutea, Vascular sclerosis may also play an important part, and hence it is more common after the age of forty. The common causes are tobacco, alcohol and occasionally lead, etc.

Symptoms. — Gradual failure of vision. The patients see best in a dull light. Both eyes are affected. The central vision is often very defective. There is a central scotoma for colours which may be so large as to make the patient colour blind. It is usually larger for green than for red.

Ophthalmoscopically no changes may be noticeable. Often the temporal half of the disc is pale, and there may be slight irregularities in pigmentation in the macular region.

(For diagnosis, *see* retro-bulbar neuritis, p. 246.)

Treatment consists in leaving off the use of the poison with the administration of gradually increasing doses of strychnine.

The prognosis is good provided that the disease has not lasted a long time and that vascular sclerosis is not marked.

Other disturbances of vision without ophthalmoscopic changes.—Scintillating Scotoma.—Migraine is sometimes associated with central luminous scotomata or loss of sectors from the fields, which may last from one to three hours and are usually followed by intense headache and vomiting.

Treatment.—Errors of refraction should be corrected. Large doses of quinine at the onset of the symptoms will often prevent the subsequent headache.

Amblyopia (weak sight) and amaurosis (absolute blindness) are the terms used for different degrees of defective vision.

Congenital Amblyopia is sometimes present when the patient has had defective vision from an error of refraction or other cause.

Amblyopia ex Anopsia is the blindness in a squinting eye which results from want of use.

Amblyopia and Amaurosis may be of central origin, as in uræmia, hysteria and neurasthenia.

Optic Amnesia or *mind blindness,* is the loss of power of recognizing objects.

Malingering.—If a patient complains that he is unable to see with one eye, one of the following tests will usually suffice to distinguish a malingerer.

1. A spectacle frame containing a red and green glass is put before the eyes. The patient is then directed to read red and green letters in a frame. If the failure of sight is genuine, the patient is only able to read the red letters with the eye having the red glass in front of it and the green letters with the green glass.

2. Depends on the presence of binocular vision. A 12° prism base out is placed before the eye, and if the patient makes a correction (i.e. squints) binocular vision is present.

3. The comparative reaction of the pupils to light is also of great use.

4. A + 10 sph. is placed before both eyes and the patient is made to look at Snellen's test type, the glass before the bad eye is then neutralized by — 10 and a low + glass is put before the good eye; the patient is then asked to read, and if he does so he is malingering.

Alexia.—*Word blindness*, the inability to understand printed matter; it may be congenital or acquired.

Visual Aphasia, inability to name objects seen.

Dyslexia, inability to read more than a few words consecutively.

Colour Blindness (*see* p. 23).

Erythropsia or red vision occurs sometimes after cataract extraction and in neurotic children; as a rule it disappears spontaneously.

Optic Atrophy.—Optic atrophy may be (1) *primary*, without previous inflammation of the optic nerve; (2) *secondary* to inflammatory disturbances.

1. **Primary Optic Atrophy** is distinguished by the greyish-white appearance of the papilla, which has sharply defined edges. The disc is often slightly

cupped, the lamina cribrosa being apparent as greyish areas. The retinal vessels are unchanged, and as the atrophy progresses the patient becomes blind.

The chief causes are :—

1. Spinal affections, especially tabes. It is therefore important to look for the Argyll-Robertson pupil and to try the knee jerks.

2. Cerebral affections, such as disseminated sclerosis.

3. Retro-bulbar neuritis and lesions of the nerve behind the entrance of the retinal vessels may give rise to the appearance of a primary optic atrophy at the nerve head, but this is not, strictly speaking, primary. They are usually unilateral.

2. **Secondary Optic Atrophy** follows on (1) optic neuritis (neuritic atrophy) ; (2) degenerative changes in the retina (retinitic atrophy).

In **Neuritic Atrophy** the disc is white in colour, the edges blurred ; the veins may be full, or the vessels small in the later stages. The lamina cribrosa is not seen owing to the disc being filled with fibrous tissue and white lines are often present along the vessels. The causes are those already given under optic neuritis (Plate IV).

In **Retinitic Atrophy** the disc is greyish-red ; the vessels extremely contracted ; it is associated with other changes in the retina as for instance in retinitis pigmentosa (Plate IV).

Prognosis and Treatment depend entirely on the

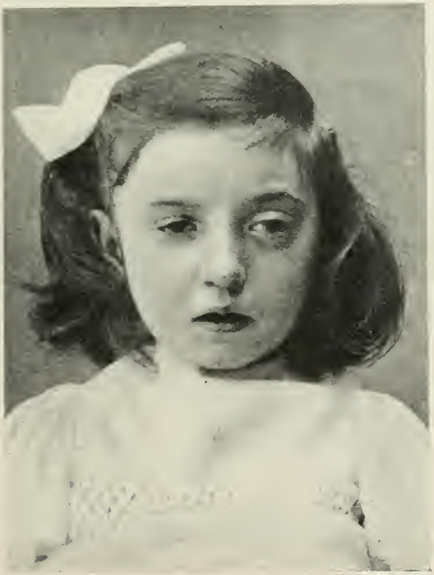


Fig. 79.—Tumour of the optic nerve (neuro-fibromatosis). Left eye showing the proptosis—the eye is pushed straight forward.

cause. In tabes, when the optic atrophy is complete, the disease often does not progress.

Tumours of the Optic Nerve are (1) intradural, the commonest of which is a neuro-fibromatosis; (2) extra-dural, the commonest of which is sarcoma.

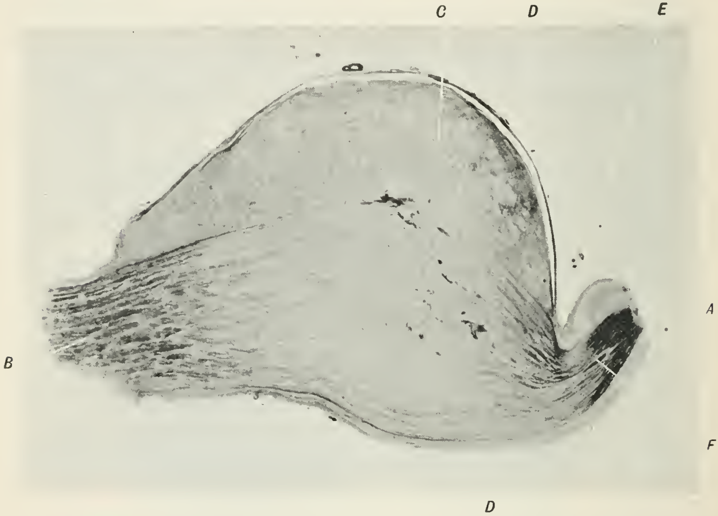


FIG. 80.—Longitudinal section of the tumour (neuro-fibromatosis).

A. The nerve divided close to the globe.
B. The thickened nerve at the optic foramen.
C. Overgrowth of the supporting structure of the nerve.
D. Dural sheath of the nerve.
E. Kinking of the nerve causes pressure on the vessel and thus produces optic neuritis.

Neuro-Fibromata make their appearance before the age of sixteen. The symptoms to which they give rise are (*a*) loss of vision; (*b*) proptosis, the eye being pushed straight forwards with little or no loss of movement; (*c*) increasing hypermetropia; (*d*) optic neuritis or secondary atrophy (Figs. 79, 80); orbital cysts lying within the cone formed by the muscles give rise to similar symptoms with the exception that optic neuritis is usually absent.

Treatment consists in an exploratory operation by Kronlein's method (*see* p. 370), and removal of the tumour, leaving the globe in position if possible.

The prognosis for non-malignant cases is good, although usually some defect in outward movement of the eye remains after operation.

CHAPTER VIII

GLAUCOMA

Glaucoma is a disease characterised by increase in the intra-ocular tension of the eye. When no antecedent disease is known to be present it is called (1)—primary; when there has been previous disease, (2)—secondary. The condition may be acute or chronic.

Anatomy and Physiology.—The fluid in the anterior and posterior chambers of the eye is secreted from the ciliary body by a process of modified filtration. From the posterior chamber it passes into the anterior through the pupil; from the anterior it filters at the angle of the anterior chamber through the ligamentum pectinatum into the canal of Schlemm, from this it is carried into the blood stream by the venous anastomosis in that region (Fig. 81, and Plate II).

The essential change found in all cases of glaucoma is the blocking of the angle of the anterior chamber owing to the root of the iris being applied to the back of the cornea, hence preventing the filtration of the fluid into the canal of Schlemm (Figs. 82, 83).

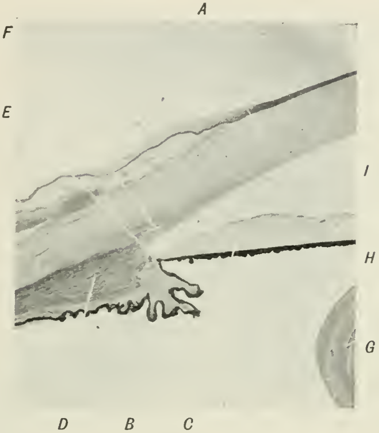


FIG. 81.—The normal angle of the anterior chamber.

A. Cornea.
B. Ciliary processes.
C. Iris.
D. Ciliary muscle.
E. Pectinate ligament, to the right of which is the angle of the chamber.
F. Canal of Schlemm.
G. Lens.
H. Posterior chamber.
I. Anterior chamber.

The exact cause of the pushing forwards of the root of the iris is often doubtful but there are several predisposing causes.

1. **Age.**—Glaucoma is most common between the ages of fifty and seventy, this is probably due to the increasing size of the lens associated with advancing years.

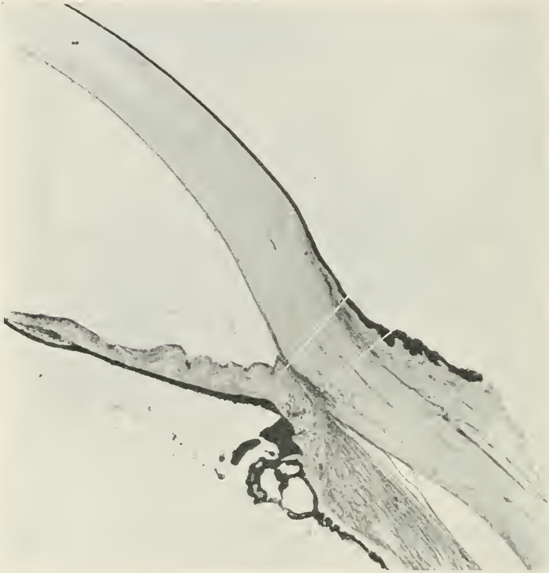


FIG. 82.—The angle of the ant. chamber from a case of recent glaucoma showing its occlusion by the base of the iris (*A*) being adherent to the posterior surface of the cornea ; canal of Schlemm (*B*).

2. **Hypermetropia.**—The enlarged ciliary body produced by excessive use of the ciliary muscle in

accommodation together with the large size of the lens relatively to that of the globe, tends to block the angle of the chamber. Hence the frequency of glaucoma in microphthalmic eyes. Acute primary glaucoma practically never occurs in myopia.

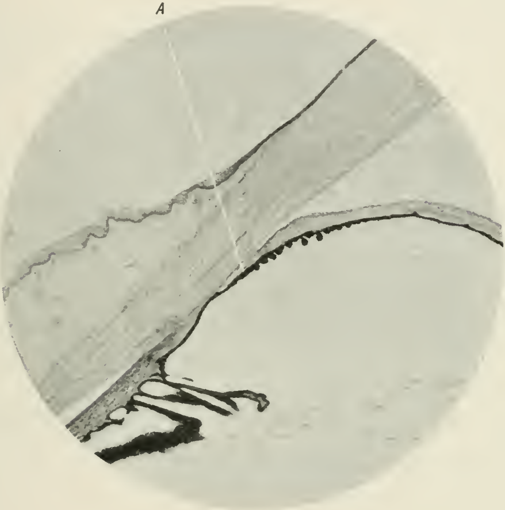


Fig. 83.—The angle of the chamber in a case of glaucoma of long standing.

The iris (*A*) has become atropic at its root. An iridectomy in this case would not free the angle of the chamber, as the iris would separate at the point *A*, and the canal of Schlemm would still remain blocked by the root of the iris.

3. **Disturbances of the Intra-Ocular Circulation.**—Thrombosis of the central vein (vascular sclerosis) and intra-ocular hæmorrhage are often followed by glaucoma.

Often a history of worry and grief precedes an attack of acute glaucoma. This is probably due to the congestion produced by emotion.

The actual increase in tension may be brought about either (1) by an increase of secretion from the ciliary body, as in the early stages of cyclitis, or (2) by a diminished excretion from the angle of the chamber, as when blocked by the root of the iris, or (3) from the alteration of the consistency of the fluid, as when loaded with albumen in cyclitis.

Increase of tension brings about the following changes in the eye :—

1. *Cupping of the disc* is produced by pushing backwards of the lamina cribrosa and atrophy of the nerve fibres at the disc. It is recognized with the ophthalmoscope by observing the vessels as they pass over its edge, when they appear bent or broken (Plate V and Fig. 84). The focus of the vessels at the bottom of the disc differs from that of other parts

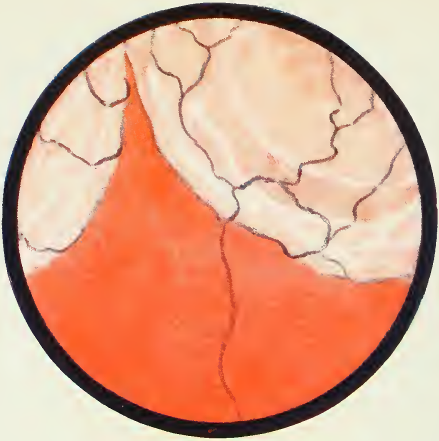


FIG. 1.—RETINAL DETACHMENT FOLLOWING A BLOW.

When the vessels in the detachment are in focus those in the attached portion are not clearly defined.

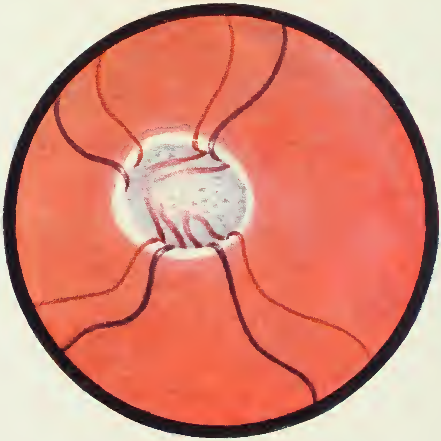


FIG. 2.—DEEP GLAUCOMATOUS CUPPING OF THE DISC, FROM A CASE OF CHRONIC GLAUCOMA (LATE STAGE).

Note the broken appearance of the vessels at the disc margin due to the overhanging edge of the cup. The grey disc with the lamina cribrosa is shewn distinctly as the result of atrophy of the nerve fibres.

To face page 263.] [*Plate V.*

of the retina. A glaucomatous cup is distinguished from a physiological one by the fact that the cupping extends up to the margin of the disc, and from cupping due to optic atrophy by the shallow nature and white appearance in the latter cases. In some cases of very chronic glaucoma it is sometimes difficult to distinguish between these two conditions.

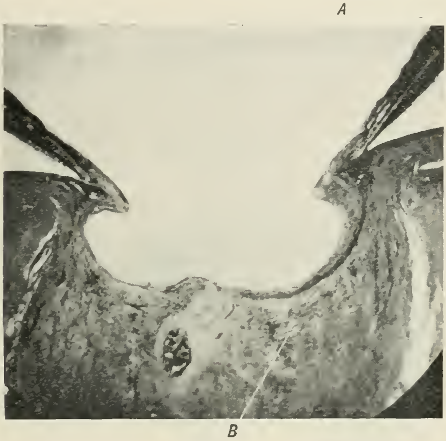


FIG. 84.—Glaucoma. Cupping of the disc.

The overhanging edges (*A*) give a broken appearance to the vessels as they pass down the sides of the cup seen in Plate V. The lamina cribrosa (*B*) is displaced backwards.

2. *Pulsation of the retinal artery* is looked for on the disc; it is a sure sign of increased intra-ocular

tension, provided heart disease (the only other cause) be excluded.

3. *Loss of Vision.*—The loss of vision may be rapid in the acute cases but is gradual in the chronic. It consists in a contraction of the field, often in the form of a sector from the nasal side (Fig. 85). The macular region frequently remains unimpaired for a considerable time so that patients say they see as though down a tube. There is also an enlargement of the scotoma corresponding to the blind spot region.

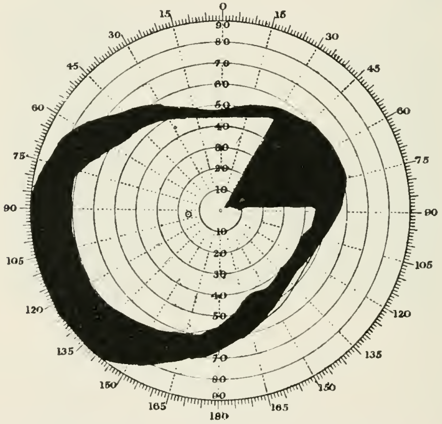


FIG. 85.—The field from a case of chronic glaucoma; note the contraction on the nasal side.

4. *Steamy cornea* is due to œdema of the epithelium, which appears roughened on the surface. Large bullæ of the epithelium are sometimes present, especially in the advanced stages.

5. *Anæsthesia of the cornea* is present in acute cases and is due to pressure on the ciliary nerves as they course forward through the choroid.

6. *Dilatation and inactivity of the pupil* from a similar cause.

7. *Ectropion of the iris* due to paralysis of the sphincter muscle, the uveal pigment at the margin of the iris being thus brought more into view.

8. *Enlargement of the episcleral vessels* owing to the defective intra-ocular circulation.

Primary Glaucoma.—**Symptoms.** — *Prodromal.* Rapidly increasing presbyopia due to defective accommodation ; rainbows seen around lights owing to increased tension caused by the dilation of the pupil at night and by œdema of the cornea ; patients often also complain of flashes of light and of seeing objects as through a fog. In *chronic cases* these are the only subjective symptoms which may occur except the advancing failure of vision owing to the gradual contraction of the fields. On examination the most constant change is cupping of the disc; the tension may or may not be increased at the time of examination, but usually the anterior chamber is shallow and the pupil sluggish. The episcleral vessels may be slightly enlarged.

In *acute cases*. The acute attacks may be primary or follow on the chronic form. The patient feels ill; there is intense pain in the eye with redness and in bad cases œdema of the conjunctiva. Frequently vomiting takes place which, in the inexperienced, may lead to a mistaken diagnosis of gastric disturbance associated with a cold in the eye. The vision fails rapidly and in bad cases perception of light only may be present within a few hours of the commencement of the attack. The pupil is dilated, the cornea steamy and anæsthetic, the media so hazy that the fundus is not seen. If the tension be not relieved the disease goes on to complete blindness after one or more attacks.

Diagnosis.—Primary acute glaucoma, as has already been pointed out, may be overlooked altogether.

It is liable to be mistaken for iritis. The following are the chief points to look for in making the differential diagnosis :—

Iritis.	Glaucoma.
Tn	T+
Pupil small and contracted	Pupil dilated and inactive.
Cornea clear ; keratitis punctata may be present.	Cornea steamy ; keratitis punctata absent.
Iris discoloured with loss of pattern ; no ectropion of the iris.	Very slight discolouration ; no loss of pattern ; ectropion of the iris.
Anterior chamber normal or deep.	Anterior chamber very shallow.
Disc normal.	Disc cupped.
No contraction of the field.	Field contracted.

Although these are the main points to be looked for, the diagnosis may be extremely difficult, as cases of iritis and irido-cyclitis are not infrequently associated with increased tension (secondary glaucoma). The presence of keratitis punctata is most important in making the diagnosis clear.

Chronic glaucoma may be overlooked, the case being taken for an error of refraction and a mydriatic used, with perhaps direful results, e.g. an acute attack of glaucoma.

Treatment. — *Prophylaxis.* The greatest care should be taken in the use of mydriatics, especially for errors of refraction. If homatropine is used in patients over thirty, eserine should be subsequently instilled.

In *acute glaucoma* the treatment is an immediate iridectomy. As a temporary measure eserine (grs. 2 to the oz.) should be instilled into the eye every half hour until the pupil is contracted, while leeching for the pain and a sharp purge are beneficial. If this does not lower the tension and the patient has to wait a day or two for the operation, a posterior scleral puncture should be performed.

The prognosis is good if the attack be of short duration. If the attack is very acute, blindness may supervene in twenty-four hours (fulminating glaucoma).

The operation may be one of the most difficult which an ophthalmic surgeon is called upon to perform. The anterior chamber being little more than a potential space the lens is very liable to be wounded by the point of the knife. If such an accident happen a traumatic cataract follows which may require subsequent extraction (*see* p. 339).

In *chronic glaucoma* the results of iridectomy are not so satisfactory, as, owing to the slow progress of the disease, the iris becomes atrophic and adherent to the cornea at the angle of the anterior chamber. When the iridectomy is performed the angle is not opened up owing to this adhesion. If an operation, therefore, is to be successful it should be performed as early as possible and should be wide in extent. Although the opening up of the angle of the chamber by tearing the iris away from its root is the most successful way of relieving the tension, relief may be obtained in another manner, namely, by allowing the aqueous to filter through a weakened portion of the scar. Unfortunately this condition is dangerous owing to the fact that any conjunctivitis in the neighbourhood of the wound may spread into the interior of the eye and set up cyclitis. A few rare cases of chronic glaucoma are controlled by the use of eserine.

Blind glaucomatous eyes, if causing pain, should be enucleated.

Secondary Glaucoma.—The precursory conditions which give rise to secondary glaucoma are :—

1. Occluded and excluded pupil.

2. Early stages of cyclitis.

3. Perforation of the cornea with anterior synechiæ.

4. Dislocation of the lens.

5. Wounds of the lens.

6. Operations on the eye, e.g. after cataract extraction due to entanglement of the capsule.

7. Intra-ocular growths (*see* Sarcoma of the Choroid, p. 189).

8. Intra-ocular hæmorrhage.

9. Congenital malformations, e.g. aniridia and buphthalmos.

The blocking of the angle of the anterior chamber is the chief factor in 1, 3, 4, 6, 7 and 8; alteration in the consistency of the aqueous in 2 and 5, and increased secretion in 2 also play an important part. For treatment see under the various diseases described.

9. **Congenital Malformations.**—**Aniridia** (absence of the iris).—In microphthalmic eyes and in cases

of maldevelopment of the iris the angle of the anterior chamber is imperfectly formed owing to the faulty development or incomplete separation of the iris from the back of the cornea, with the result that there is an early onset of glaucoma.

Buphthalmos or ox eye, is a condition which is often hereditary and frequently affects both eyes. It is due to increased intra-ocular tension in early life. The globe, instead of becoming very hard, yields, with the result that the coats become thin and the whole eye, including the cornea, very large. The disc is cupped.

The chief causes of the condition are :—

1. Congenital absence of the canal of Schlemm.
2. Imperfect separation of the iris from the back of the cornea.
3. Neuro-fibromatosis of the ciliary nerves.

In the first two instances cases have been arrested by iridectomy in the early stages. When due to neuro-fibromatosis it is usually associated with a similar condition in the other branches of the fifth nerve and in this case little can be done.

CHAPTER IX

DISORDERS OF THE EXTRA-OCULAR MUSCLES AND MOVEMENTS OF THE EYE

Anatomy and Physiology. — The eyeball rotates round a point 2 mm. behind its central antero-posterior axis, which is 24 mm. in length. The movement is effected by six pairs of muscles which are antagonistic in their action ; thus the *external rectus,* which pulls the eye directly outwards, is in direct opposition to the *internal* which pulls the eye directly inwards.

The Superior and Inferior Recti in their action do not correspond to the vertical plane, for as well as pulling the eye up and down they cause it to rotate (wheel motion) the superior inwards, the inferior outwards.

The Oblique muscles are inserted behind the central point of rotation, the superior causing rotation downward with wheel motion inwards, the inferior causing upward rotation with wheel motion outwards.

In considering the movements of the eyeballs we have to think of the associated action of one eye with the other. Thus the internal rectus of one side acts with the external rectus of the other. In a similar way all the other muscles are associated. Thus the wheel motion to the right is carried out by the superior oblique of the left side and the inferior oblique of the right side.

In the so-called primary position, the eyes look straight forward in the distance, the images of an object falling on the macula of each eye. The axis through which these rays pass is known as the visual axis; the angle which this forms with the true optical angle of the eye is known as the angle 'Gamma.' If this angle varies widely it gives rise to apparent squint. Thus it is usually high in hypermetropia, which gives rise to an apparent divergent squint, and low, or even negative, in myopia, giving rise to an apparent convergent squint.

To determine whether a Squint is apparent or real.—There are two tests—

1. Make the patient look at some object in the distance. Then cover up the fixing eye, when the

originally squinting eye will immediately make a movement, either in or out, in order to fix the object, and the covered eye will be found to be squinting; then rapidly uncover, and it will be found that the eyes will resume their original position (movement of redress) provided the squint is not an alternating one, in which case the eyes will undergo no movement when uncovered.

2. In a dark room direct the patient to look straight in front of him, and throw a light from the ophthalmoscopic mirror on to the eyes. It will be noted that the reflex of light from the surface of the cornea is not centrally situated in the squinting eye. This is a most useful test for small children.

Squint.—Strabismus is divided into *concomitant* and *paralytic*. To distinguish a concomitant squint from a paralytic squint the chief points of difference are—

CONCOMITANT.	PARALYTIC.
1. The movements of the eyes are good in all directions.	1. Defective movement to the paralysed side, therefore the squint becomes more apparent on looking in the direction of action of the paralysed muscle.

CONCOMITANT.	PARALYTIC.
2. No diplopia.	2. Diplopia is always present, and the images always become more separated on looking in the direction of action of the paralysed muscle
3. Primary and secondary deviations are equal.	3. The secondary deviation (e.g. the deviation of the sound eye whilst the affected eye fixes) is greater than the primary deviation (e.g. when the sound eye fixes and the affected eye squints) because the muscle of the sound eye, which is associated in its action with the paralysed muscle in the affected eye (e.g. the right internal rectus with the left external rectus) must receive a nervous impulse of equal intensity to that sent to the weak muscle, and as the latter requires an excessive stimulus to excite any action, its associate will over-act.

Concomitant Squint.— **Ætiology.** — There are three theories advanced for the explanation of concomitant squint, all of which are probably factors in its production.

1. *The muscle theory,* which supposes that there is some developmental inequality or faulty insertion of muscles into the globe.

2. *The accommodation theory.*—In hypermetropia, where convergence is associated with accommodation, internal strabismus results, whereas in myopia, where accommodation is not required, divergence takes place.

3. *Failure in development of the fusion sense.*—When a child is born the eyes move independently of each other and hence new-born children often appear to squint. As they begin to take notice of surrounding objects they develop the power of fusion. The two images which fall on the maculæ are fused by the brain, the centre being known as the "fusion centre," or centre for binocular vision. If one eye is defective from any cause, or the balance of muscles unequal, binocular vision does not develop and a squint may result.

Binocular Vision is of three grades—

(*a*) The power of seeing objects with each eye individually at the same time, i.e. the pictures on either side of a stereoscope.

(*b*) Fusion power, i.e., the superimposing of the picture on either side of a stereoscope.

(*c*) The sense of depth, i.e., the figures appear solid in a stereoscopic picture, the distance of objects from the eyes being judged by the amount of convergence required.

Latent Squint is the condition in which the fusion sense keeps the eyes parallel, but there is an inequality of muscular balance due to faulty insertion, etc. Thus when the fusion sense is done away with by covering one eye the squint becomes noticeable. Sometimes the effort which is made to keep the visual axes parallel gives rise to headache, vertigo and even vomiting. Diplopia may result from failure to maintain the axes of the eyes parallel.

To test the Muscular Balance.—The patient is placed in a dark room and is told to look at a small light six metres distant. A Maddox rod (Fig. 86), which consists of a number of glass cylinders, is placed before the left eye, in order to destroy temporarily any sense of fusion. The image of the light produced by the Maddox rod appears as a single bright band.

In *orthophoria,* or normal muscular balance, the bar of light falls through the centre of the flame, both when the rod is placed in the vertical or in the horizontal direction.

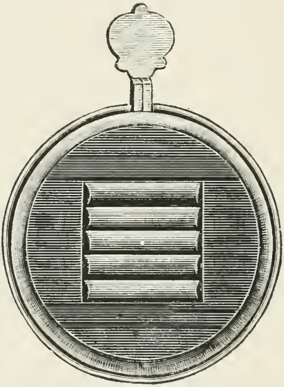


FIG. 86.—Maddox Rod.

In *exophoria,* or latent divergence, the vertical band is to the right of the light.

In *esophoria,* or latent convergence, the vertical band is to the left of the light.

In *hyperphoria,* or latent vertical squint, the horizontal band is above or below the light.

The images are reversed if the rod is used in front of the other eye. The amount of muscular error is estimated by placing prisms before the eye so as to bring the image produced by the rod directly over the light, the number of the prism representing the amount of error. The Maddox tangent scale can also be used for the same purpose.

Treatment.—Low degrees of muscular error often cause no symptoms. If symptoms are present, the muscular error may be overcome by the use of prisms, when half the amount estimated should be corrected. If there is a high degree of error, i.e. over six prisms, divergence, or eight prisms convergence, a tenotomy should be performed, in the case of exophoria, of the external rectus, in esophoria, of the internal rectus, and in hyperphoria of the superior rectus. Where hyperphoria is associated with exophoria or esophoria, the latter should be treated first, as the hyperphoria may disappear after their correction.

Careful testing with the Maddox rod should be carried out during the operation, so as to get the visual axes parallel. The operation, therefore, should always be done under adrenalin and cocaine.

Manifest squint may be (1) periodic or occasional, i.e. sometimes latent and sometimes manifest.

(2) When the squint has lasted for some time the patient often uses each eye alternately (alternating strabismus).

(3) The use of one eye to the exclusion of the other. This is more liable to be the case if one eye was defective before the onset of the squint (then known as fixed strabismus). If the eye is not used it becomes amblyopic (amblyopia ex anopsia) and after a time fixation may be lost. The vision of this eye may be improved, if the patient is seen sufficiently early, by covering up the sound eye.

To measure the Amount or Angle of the Squint.—The perimeter is the instrument most commonly used. The patient is placed before the perimeter, the arm of which is placed horizontally. A spot is marked on the wall in a line with the patient's eye, and the central point of the perimeter. He is directed to look at this spot. A lighted candle is then carried round the arc of the perimeter, so as to bring the reflection of the light on to the centre of the cornea of the deviating eye. The number of degrees marked on the back of the perimeter represent the amount of deviation. The surgeon stands directly behind the candle in carrying out these measurements. Other more accurate methods by the Maddox tangent scale and by special instruments have also been devised.

Treatment.—The treatment consists in—

1. Correcting the error of refraction.
2. The education of the amblyopic eye.

This can be carried out by covering the sound eye, or if fixation exists in the squinting eye, by instilling atropine into the sound eye.

3. The education of the fusion sense with the stereoscope.
4. The readjustment of the muscles by operation.

The first three of these methods will frequently bring about a cure in early cases, failing which an operation should be performed.

In the case of *concomitant convergent strabismus* the use of atropine is effectual in doing away with the desire for convergence.

Tenotomy of the internal rectus for squints under an angle of twenty degrees, or combined with advancement of the external rectus in cases over this amount. If both these operations are insufficient, tenotomy of the internal rectus of the other side may be necessary. It is important that the adjustment should be accurate in cases in which binocular vision is desired, and therefore the operation should always be done under adrenalin and cocaine, with the use of the Maddox rod, except in the case of very small children.

In concomitant divergent strabismus tenotomy of the external rectus should always be associated with advancement of the internal rectus, as tenotomy alone is practically never sufficient. The education with the stereoscope should be continued after the operation, provided the eye is not amblyopic. No squint can be said to be cured until full stereoscopic vision has been obtained and the danger of subsequent deviation averted.

Paralytic Strabismus.—**Ætiology.**—Lesions of the nerves causing ocular paralysis may be—

1. Orbital.
2. Basal.

3. Pontine or nuclear.
4. Cerebral.

Symptoms.—The symptoms of extra-ocular paralysis are :—

1. Diplopia.
2. Indistinct vision.
3. Vertigo, and even vomiting.
4. Holding of the head towards the lines of action of the paralysed muscles in order to lessen or get rid of the double image, or even closing of the affected eye.

Method of Investigation.—When it is not obvious by the loss of power in movement of the globe as to which muscle is paralysed, the double images are examined. The patient is placed in a dark room, and a spectacle frame, containing a red glass on one side and a green glass on the other, is put in front of his eyes. He is then asked to look at a lighted candle, and to indicate which is the true image and which is the false ; this he can readily do by trying to take hold of it.

The false image is always projected to the line of action of the paralysed muscle, e.g.

Right internal rectus—divergent strabismus, false image to left, and crossed diplopia.

Right external rectus—convergent strabismus, false image to the right and homonymous diplopia.

Right superior rectus—loss of upward movement. Diplopia in upper half of the field only, the false image is higher, crossed, and tilted outwards.

Right inferior rectus—loss of downward movement. Diplopia in the lower half of the field only, the false image is lower, crossed, and tilted inwards.

Right superior oblique—diplopia in lower half of the field, is lower, homonymous and tilted inwards to the true image.

Right inferior oblique—diplopia in the upper half of the field only, the false image is higher, homonymous, and tilted outwards.

The difficulty to the beginner is in distinguishing the superior oblique and the inferior oblique from the superior rectus, but this is easily distinguished if it is remembered that the oblique give rise to homonymous diplopia and the recti to a crossed diplopia. The following diagrams will also help—(Figs. 87 and 88).

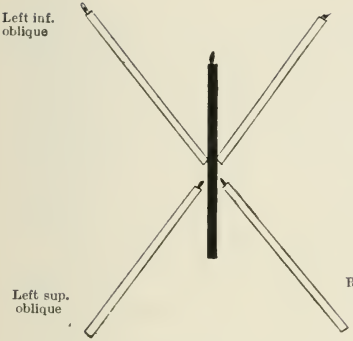


FIG. 87.—Showing the position of the false images in paralysis of the superior and inferior oblique. The dark candle is the true image.

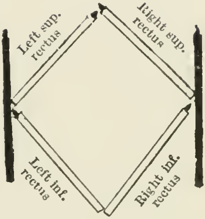


FIG. 88.—Showing the position of the false images in paralysis of the recti muscles.

Basal Paralyses are the commonest cause of extra-ocular paralysis and usually involve the whole nerve affected. The chief causes are :—fractures of the skull, meningitis, cerebral tumours, and periostitis. Paralysis of the following nerves gives rise to the corresponding ocular symptoms—

3rd nerve.—Ptosis (paralysis of the levator palpebræ superioris), dilation of the pupil (paralysis of sphincter muscle), external strabismus (paralysis of the superior, inferior and internal recti and inferior oblique).

4th nerve.—Diplopia in the lower half of the field (paralysis of the superior oblique).

5th nerve.—Anæsthesia of the conjunctiva and cornea, the latter being liable to ulceration.

6th nerve.—Internal strabismus (paralysis of the external rectus).

7th nerve.—Inability to close the lids (lagophthalmos) with epiphora as the result.

Nuclear or Pontine Paralyses may only involve part of the nerve centre, as for instance in Argyll Robertson's pupil, or may affect parts or the whole of several nerve centres, as in ophthalmoplegia.

Ophthalmoplegia is a nuclear paralysis affecting groups of muscles of the eye including the levator palpebræ. If the extra-ocular muscles are affected it is known as ophthalmoplegia externa; interna, if the pupil and accommodation are affected; and total, if both are paralysed.

The lesion may be acute (acute polio-encephalitis) or chronic. It may be associated with chronic bulbar paralysis, progressive muscular atrophy, and locomotor ataxy.

Diagnosis.—It is sometimes simulated by acute peripheral neuritis associated with lead poisoning or alcohol. It is also simulated by tumours of the pons.

Cerebral Paralysis usually affects the associated movements of the eye.

Conjugate Paralysis, or loss of power of looking to one side, although the power of convergence is retained, may be due to either pontine or cerebral lesions.

In destructive cerebral lesions, the eyes are turned away from the paralysed side ; in destructive pontine lesions, towards the paralysed side.

Lesions of the pons and cerebral cortex also cause hemiplegia. In the case of the pons it is a crossed paralysis, i.e., the eyes will turn towards the paralysed side ; if cerebral, the eyes will turn away from the paralysed side. If instead of the lesion being destructive it is irritative, convulsions will take the place of paralysis, and the position of the eyes will be reversed.

Ophthalmic Migraine is the term given to cases of ocular paralysis, probably of basal origin, which are preceded by intense pain in the head, vertigo and vomiting. It often occurs in more than one member of the same family. The paralysis usually passes off in the course of a few weeks, but may become permanent.

Treatment and Prognosis of Ocular Paralysis.—The treatment consists, when no known cause is present, or if syphilis be suspected, in the administration of iodide of potassium. Many of these cases often clear up rapidly, especially when associated with tabes, but are liable to recur and may remain permanent.

Nystagmus is the term applied to the involuntary oscillation of the eyeballs. The movements may be lateral, vertical, or rotatory. It is associated with—

1. Defective vision, e.g., congenital malformations of the eye, microphthalmos, congenital cataract, and albinism.

2. With head nodding, of which there are two types :—

(*a*) Spasmus nutans of infants, which disappears as the child grows up, leaving no after effects. It is associated with rickets, teething, etc.

(*b*) Congenital head nodding and nystagmus, which date from birth and persist to adult life. The vision in these cases is always very defective.

3. With disease of the nervous system, especially disseminated sclerosis, cerebral diseases, and post-basic meningitis.

4. With certain occupations, e.g. miners nystagmus. In these cases the vision becomes very defective ; nyctalopia is often present, the patient usually makes a good recovery if removed from his occupation and if strychnine is administered.

CHAPTER X

DISEASES OF THE EYELIDS AND LACHRYMAL APPARATUS

Congenital Abnormalities.—**Coloboma** is a rare deformity, most frequently affecting the upper lid. It generally takes the form of a V shaped notch in the free border, about the junction of the middle and inner third. It is frequently associated with dermoid patches on the conjunctiva and cornea. Another rare form is a notch in the lower lid at the outer angle, which is associated with defective development of the malar and superior maxillary bones.

Treatment.—If the notches are large, the edges may be pared and brought together.

Epicanthus is the term applied to the crescentic fold of skin between the nose and the inner canthus. It usually decreases as the bridge of the nose develops, but if very marked can be remedied by the removal of an elliptical piece of skin in that region.

The following congenital deformities may also occur, but are rare—

Ablepharia.—Absence of the eyelid.

Lagophthalmos.—Short upper lid, which fails to cover the globe.

Cryptophthalmos.—The lids fails to develop, and the conjunctiva and cornea are represented by skin.

Symblepharon.—Adherence of the lid to the globe.

Ankyloblepharon.—Adherence of the lids to each other.

Blepharophimosis.—Small palpebral aperture.

Ectropion.—Eversion of the lids.

Entropion.—Inversion of the lids.

Trichiasis.—Inversion of the lashes.

Distichiasis.—Double row of lashes.

Congenital Ptosis is due to the defective development or absence of the levator palpebræ superioris. It may be complete, when the lid covers the globe entirely, or partial. In the latter case the appearance of the patient is characteristic. The lids droop, and the head is thrown back in order to to enable the patient to see beneath them. It is frequently associated with defective upward movement of the globe.

Diagnosis.—Congenital ptosis has to be distinguished from ptosis from other causes, which are—

1. Paralysis of the 3rd nerve.

2. Paralysis of the cervical sympathetic.

3. Injury to the levator palpebræ.

4. A certain amount of ptosis frequently present in old people.

5. Trachoma.

6. Pseudo-ptosis, due to swelling of the lid as in myxœdema, angio-neurotic œdema.

Treatment.—Many operations have been devised to relieve this condition, but they are all far from satisfactory. Operations should, therefore, only be undertaken when the vision is interfered with by the falling lid. If there is some movement in the eyelid, showing that the levator palpebræ superioris has a certain amount of power, the advancement of that muscle is desirable (Eversbuch's operation, *see* p. 355). If there is no movement of the eyelid it should be shortened and attached to the occipito-frontalis. (Hess'- Panas'-operations, *see* pp. 353, 354.)

Œdema of the Eyelids (non-inflammatory) may be due to—

1. Constitutional diseases, e.g., of the kidneys and heart and myxœdema.

2. Emphysema following fractures of the lachrymal bone due to a blow.

3. Angio-neurotic œdema—a condition which most commonly occurs in women, is transient and recurrent and is probably of the nature of urticaria.

4. Lymphatic obstruction (solid œdema).

Inflammation of the Lids.—*Blepharitis* may be primary, or secondary to inflammation in the orbit, etc.

Abscesses are usually associated with intense œdema, redness and purplish discolouration of the eyelids. They should be opened and drained as soon as the presence of pus becomes evident.

Ulceration of the lid may be traumatic, syphilitic, tubercular, vaccinial, or malignant, and should be treated accordingly.

Inflammation of the Tarsus—Tarsitis—is a slow, painless, enlargement of the tarsus, tertiary syphilitic in origin.

Affections of the Eyelashes.—Inflammation of the follicles of the eyelashes (**ciliary blepharitis**) occurs in three forms—

1. *Pustular*—tinea tarsi—is characterized by the formation of *styes*, followed by loss of the lashes, which fall out so that the lid margins become red and inflamed and the eyelashes practically absent. As the result of the inflammation the puncta become everted and epiphora results, aggravating the condition considerably.

2. *Seborrhœa* is a condition closely allied to the corresponding skin affection occurring in the scalp. There is usually a slight amount of secretion adherent to the lid margins, which are often red and inflamed. The condition, which is aggravated by the rubbing of the eyes, is in many cases associated with errors of refraction.

3. Secondary to conjunctivitis, which may infect the hair follicles.

Treatment consists in the removal of the discharge, for which a bicarbonate of soda lotion (5 grs. to the oz.) is given, followed by the rubbing into the lids of some antiseptic ointment, e.g., ung. hyd. nit. dil. Errors of refraction should be corrected. In advanced cases, in which the constant irritation has resulted in eversion of the puncta, these may require enlarging inwards in order to prevent epiphora. The general health of the patient should be improved by cod liver oil or syr. ferri phos. co. Not infrequently the condition is due to infection from the nasal discharge which is so often met with in children.

Hordeolum—*Styes*—are due to suppuration in the hair follicles, and are almost invariably staphylococcal infections.

Treatment.—During the preliminary stages, it is best to apply hot fomentations continually. Directly the pus has formed it should be evacuated; and later the treatment as advised for ciliary blepharitis must be applied. If fresh crops reappear, in spite of treatment, inoculation with the staphylococcus vaccine is advisable.

Pediculi Pubis occur on the lashes, and at first sight the condition simulates blepharitis until more closely examined. Pediculi capitis never occur on the lashes. The affection is best treated with mercurial ointments.

Trichiasis (acquired).—Ingrowing eyelashes occur secondarily to inflammatory changes (1) of the lid margin (ciliary blepharitis), (2) of the conjunctiva, especially trachoma. The lashes themselves are often stunted and broken. The turning in is either due to the distortion of the hair follicles, or to the misplacement of the whole or part of the lid margin.

Treatment consists either (1) in the reposition of the lid margin by a plastic operation (Arlt's operation), or (2) the ablation of the hair follicles either by excision or electrolysis (p. 356).

Lupus not infrequently affects the lids and conjunctiva secondarily to the face, causing ectropion, especially of the lower lid, thus leading to exposure of the globe and rendering the conjunctival sac very liable to infection with pyogenic organisms which sometimes lead to destruction of the cornea by ulceration.

Diseases of the Skin of the Eyelids.—The other diseases of the skin which affect the eyelids are eczema, impetigo, milium, molluscum contagiosum, xanthelasma, vaccinia, and herpes zoster.

Tumours of the Eyelids.—**Dermoid cysts** occur at the outer and upper margin of the orbit, this is one of their commonest situations. They are small and freely moveable, and often contain hair. They are best removed through an incision over them, though the operation is usually accompanied by considerable hæmorrhage. If the cyst is not thoroughly removed a sinus is liable to form.

Chalazion, *Meibomian or tarsal cysts.*—These are small isolated tumours, which may occur in both lids. There may be one or more present at the same time, and they may attain the size of a large pea. To the finger they feel like a good sized shot. On everting the lid, the conjunctiva has usually a purplish gelatinous appearance over the cyst. They may be situated anywhere in the course of the Meibomian glands, and since these glands are imbedded in the tarsal plate, the cyst may point both through the skin of the lid and through the conjunctiva. Although usually described as cysts, they are really not true retention cysts of the Meibomian glands, but are composed of granulation tissue and retained

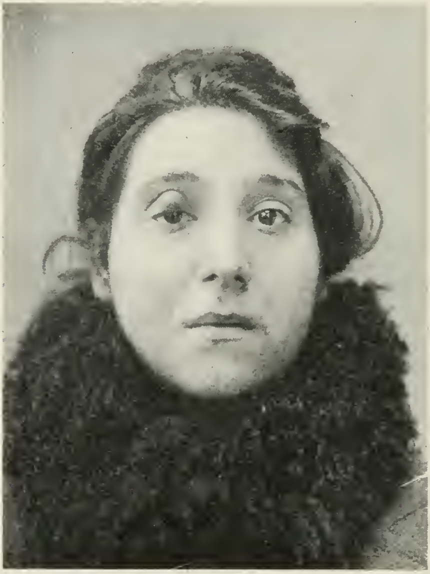


Fig. 89.—Tarsal (Meibomian) Cyst. Right upper eyelid.
The Meibomian glands being embedded in the tarsal plate, the cyst presents both on the conjunctival surface and towards the skin.

Meibomian secretion. Suppuration in them is not at all infrequent, in which cases the usual organism found is the staphylococcus.

Treatment consists in evacuating the contents through an incision in the conjunctiva, and thoroughly scraping the sac wall. The difficulties which arise are, in the case of the small cysts, in keeping them fixed whilst making the incision into them. for which purpose Graddy's forceps are of use. In some cases, the sac wall, where the cyst has persisted for a considerable time, becomes so enormously thickened that it has to be dissected out before the mass in the lid disappears. In cases of recurrent suppuration in the Meibomian glands inoculation with staphylococcus vaccine is of service.

Cysts of Moll's Glands are small white cysts formed at the lid margins, and are filled either with clear liquid or whitish secretion. They should be evacuated through a small incision, and the contents scraped out.

Naevi may be small and superficial, or deep and extending into the orbit. If small, they are best removed by excision ; if large, electrolysis is the best method of treatment.

Neuro-fibromatosis affecting the 1st division of the 5th nerve produces enormous hypertrophy of the lid, and is frequently associated with buphthalmos, in which a similar condition affects the ciliary nerves.

Lymphangioma and enchondroma may also affect the eyelids.

Malignant Tumours.—*Rodent ulcer* frequently starts about the eyelids, and may lead to their complete destruction. It is best treated either by radium or X-rays. If the bone of the orbital margin is involved, excision is the only remedy, since the X-rays will not eradicate the disease when the bone is affected.

Epithelioma occasionally occurs about the lids as a warty growth, which subsequently ulcerates. The preauricular gland is the first to enlarge. If any doubt between it and rodent ulcer arise, a piece should be removed for microscopical examination.

Entropion, or inversion of the lid, may be congenital or acquired.

Acquired entropion is divided into—

1. Spasmodic. 2. Cicatricial.

1. *Spasmodic entropion* is the result of extreme photophobia. It also occurs as the result of continuous bandaging of the eye. It always affects

the lower eyelid, which is turned inwards, as a result of which the whole row of eyelashes rub on the surface of the cornea and ocular conjunctiva, and if not remedied may give rise to ulceration of the former.

Treatment.—In the early stages the application of collodion or a piece of strapping to the outer surface of the lid, so as to pull it downwards, failing this a strip of skin and muscle should be removed from the lower lid.

2. *Cicatricial entropion* usually affects the upper lid, but both eyelids may be involved. It is usually the result of trachoma or some inflammatory lesion or burn of the conjunctiva, which by its contraction pulls the lid inwards.

Treatment is operative, by replacing the displaced margins by some such operation as Arlt's (*see* p. 357).

Ectropion, or eversion of the eyelids, may be congenital (*see* p. 291), or acquired.

Acquired.

1. Spastic.
2. Senile.

3. Cicatricial.

4. Paralytic.

1. *Spastic ectropion* is usually found in children with severe blepharospasm. It is remedied by careful bandaging, or failing this by canthotomy (*see* p. 363), which temporarily paralyses the orbicularis palpebrarum and allows the lid to come into place.

2. *Senile ectropion* occurs as the result of want of tone and flaccidity of the lower lid in old people. Epiphora, due to the eversion of the punctum, results, the patient aggravating the condition by frequently pulling down the lower lid to wipe away the tears.

Treatment in the early stages consists in applying an astringent lotion such as Zinci Chlor. grs. ii ad ℥ i, and slitting the punctum inwards. When the ectropion is marked Snellen's sutures or tarsorraphy (*see* pp. 360–363) may be required.

3. *Cicatricial ectropion* occurs as the result of burns, wounds, abscesses and lupus about the lids. (For operative treatment *see* p. 358).

4. *Paralytic ectropion*, if of long standing, may be treated in the same way as the senile form.

Symblepharon, or adherence of the eyelid to the globe, is either congenital or acquired. It is remedied by dividing the cicatricial band and avoiding fresh adhesions by grafting mucous membrane or skin, or by the interposition of tin foil, etc. (*see* p. 364).

DISEASES OF THE LACHRYMAL APPARATUS

The lachrymal apparatus consists of two parts :—

1. The lachrymal gland ; 2. lachrymal canals.

1. **The Lachrymal Gland** is situated at the upper and outer part of the orbit, and consists of two portions (*a*) the orbital and (*b*) the palpebral. These are partially separated from each other by the expansion of the tendon of the levator palpebræ. The yielding of this fascia occasionally causes displacement or dislocation of the upper part of the gland into the eyelid, where it is seen as a soft rounded swelling which can be pushed back into the orbit with the finger.

Inflammation.—*Dacryo-adenitis.*

Acute dacryo-adenitis commonly occurs in children and affects mainly the palpebral portion of the gland, the infection arising from the conjunctiva, and being carried into the ducts which open into the upper fornix.

Symptoms.—There is pain, swelling and redness of the upper lid, especially on its outer side. This swelling also affects the outer half of the conjunctiva, for inflammation of which membrane it is liable to be mistaken. As a rule, the inflammation subsides under hot fomentations in the course of a week or so—usually without the formation of an abscess. *If the deep part of the gland* is affected suppuration usually results with the formation of an abscess which may either burst through the conjunctiva or through the skin ; it may be accompanied by some proptosis. If the abscess bursts through the skin a fistula of the lachrymal gland may subsequently form.

Treatment.—During the acute stage hot fomentations should be applied. When pus has formed the abscess should be opened through the skin and drained. If a fistula should form the edges should be pared and brought together.

Chronic dacryo-cystitis may be simple or tubercular ;

both are rare. Concretions in the ducts occasionally occur.

Tumours of the Lachrymal Gland.—A cyst or "dacryops" may occur in two situations—

1. In the lid, when it gives rise to a painless fluctuating swelling containing clear fluid.

2. In the orbit, giving rise to the symptoms of an orbital tumour, the chief of which is a painless proptosis with some limitation of movement upwards and outwards. Optic neuritis is usually absent.

Treatment.—The cysts should be removed by dissection—either through the conjunctiva or through the lid.

Sarcoma and Adenoma have been known to occur, giving rise to symptoms of an orbital tumour (*see* p. 321).

2. **The Lachrymal Canals** consist of :—

(*a*) *The puncta,* which are pinhole openings found on a small eminence at the inner end of the upper and lower eyelids.

(*b*) *The canaliculi,* which lead from the puncta to the lachrymal sac and are lined by squamous epithelium.

(*c*) The *lachrymal* sac which lies in the cavity of the lachrymal bone. It consists internally of mucous membrane lined by columnar epithelium similar to that of the nose. It is crossed anteriorly by the tendo oculi and enwrapped in a differentiated portion of the orbicularis, known as Horner's muscle. It reaches to about 2 mm. above the tendo oculi and the lower end leads into the nasal duct.

(*d*) The *nasal duct,* which leads from the sac into the inferior meatus of the nose where it opens beneath the inferior turbinate bone.

Lachrymation is the hyper-secretion of tears.

Epiphora is the overflow of tears due to obstruction to their outlet. It may arise from defects (1) in the puncta, (2) in the canaliculi, (3) in the duct.

1. IN THE PUNCTA. (*a*) Congenital absence; (*b*) ectropion, either senile or as the result of blepharitis.

2. IN THE CANALICULI, (*a*) *from within,* concretions owing to the growth of leptothrix within the lumen; to the presence of foreign bodies, such as eyelashes; (*b*) *in the wall,* strictures following wounds and

operations ; (*c*) *from outside*, a tarsal cyst or stye pressing on the lumen.

Treatment.—Concretions can be removed from the canaliculus by enlarging the punctum and scraping out the contents. Strictures are best dilated by a Nettleship's dilator (Fig. 90).

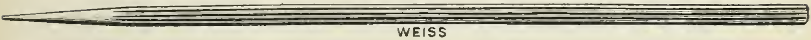


Fig. 90.—Canaliculus dilator.

3. In the lachrymal duct. Lachrymal obstruction may result from occlusion of the duct :—

(*a*) **From within.**—*Congenital lachrymal obstruction* is caused, usually, by the blocking of the duct with the epithelial débris with which the duct is filled during fœtal life and which normally is cleared by aspiration from the nose during the first few hours of life. Congenital malformations of the duct are rare and are associated with severe facial deformity.

Symptoms.—The patients are always infants under six months and are brought either with epiphora or, what at first sight appears to be ophthalmia neonatorum, but on closer examination by pressure over the lachrymal sac is shown to be a regurgitation of pus from a large mucocele (distended lachrymal sac).

Treatment consists in washing out the sac and passing a probe, one probing being sufficient to bring about a cure.

(*b*) **In the wall.**—Inflammatory changes taking place in the mucous membrane lining the duct are by far the commonest cause of lachrymal obstruction occurring in adults ; the swelling and the subsequent cicatrization cause obliteration of the lumen ; this damage is most commonly situated about the neck of the sac. As a result the sac becomes distended behind the stricture and a mucocele results, as shown by regurgitation on pressure over the sac. The sac may now become infected with pyogenic micro-organisms and suppuration take place around it with the formation of a lachrymal abscess ; finally, after the abscess is opened, or has burst, a fistula may form.

The actual cause of the primary inflammation in the mucous membrane may be (1) simple or catarrhal ; (2) tubercular ; (3) syphilitic. The source of infection is usually from the nose. It is, therefore, of the utmost importance to examine the nose in all cases of lachrymal obstruction, especially when there is any suspicion of lupus or syphilis.

(*c*) **From without.**—Periostitis and caries usually of syphilitic origin, especially the snuffles associated with the congenital form of the disease. It can be distinguished from the so-called congenital form of lachrymal obstruction by the fact that the patients are older and other signs of congenital syphilis are present.

Tumours, especially of the upper jaw and antrum, may give rise to lachrymal obstruction. In this instance the primary cause may be overlooked if the nose is not examined.

Diagnosis.—Cases of epiphora, in which lachrymal obstruction is suspected, can readily be diagnosed by syringing. If the duct is patent the fluid will then pass into the nose and run down the posterior nares.

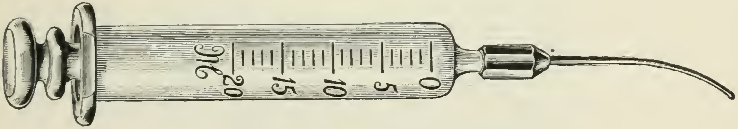
The principal causes underlying epiphora at the various times of life are :—

In the first year, congenital conditions; from the second year to adult life, congenital syphilis; in the adult, inflammatory disease, especially tubercle; in old people, inflammatory disease or new growth in the nose.

Treatment.—1. *Obstruction without regurgitation* can usually be cured by washing out the sac with some astringent lotion, such as chloride of zinc and by chloride of zinc drops given to the patient to use in the conjunctival sac.

2. *Mucocele*, if small, can sometimes be made to disappear by simply washing out the sac two or three times a week. A small quantity of protargol 10% should be left in the sac, especially when the discharge is purulent. If, after a trial of three or four weeks, this treatment fails, a probe should be passed through the canaliculus and down the duct (slitting of the canaliculus is not a justifiable operation since it does away with the capillary attraction of the canaliculus). If, after probing, there is no improvement the sac should be excised. Excision of the sac should always be performed in tubercular cases (*see* p. 365) and cases due to periostitis of long standing after recurrent lachrymal abscess and in fistula.

Method of syringing the sac.—The eye is cocainized and the patient made to look up. The punctum is everted by pulling down the lower lid. The canaliculus is then dilated by passing a Nettleship's probe followed by the nozzle of the lachrymal syringe, which should be passed until it is felt to impinge on the bony wall of the sac. Withdraw the syringe slightly and apply gentle pressure to the piston. The fluid will either regurgitate through the upper canaliculus or, if the duct is patent, pass into the nose and so down into the throat (Fig. 91).



FULL SIZE

Fig. 91.—Lachrymal syringe.

Complications.—By far the most important complication to which lachrymal obstruction gives rise is *serpiginous ulcer of the cornea,* which is usually associated with the growth of the pneumococcus in the purulent secretion within the sac. It is, therefore, of the utmost importance, not only on account of the epiphora and the possible formation of a lachrymal abscess, but also on account of this complication, that lachrymal obstruction should be cured by syringing, or failing this, that the source of infection should be removed by excision of the sac (*see* p. 365).

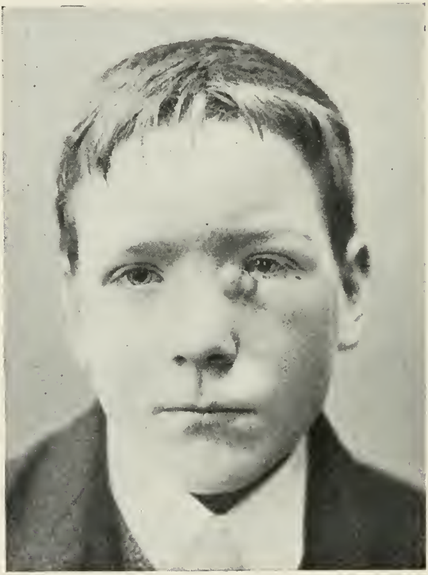


FIG. 92.—Lachrymal Abscess.

Lachrymal Abscess.—Dacryocystitis is the result of lachrymal obstruction with distension of the sac and secondary infection of the walls with micro-organisms (Fig. 92).

Symptoms and Diagnosis.—Pain, redness and swelling in the lachrymal region; in the early stages the redness may be mistaken for erysipelas from which it is usually easily diagnosed by the history of epiphora, by regurgitation on pressure over the sac, by the redness not extending over the face, and by the absence of high temperature.

Treatment consists in the use of hot fomentations and, as soon as pus can be made out, free incision and drainage. The obstruction to the duct should be treated when all signs of inflammation have subsided.

Lachrymal Fistula is the result of a lachrymal abscess which has burst and which does not heal. It should be treated by excision together with removal of the lachrymal sac.

CHAPTER XI

DISEASES OF THE ORBIT

Congenital Abnormalities.—Anophthalmos, or absence of the eyes, is a rare affection. No eyes are present but usually some pigmented cysts or hard nodules are found in the conjunctival sac. Pathologically speaking no case of true anophthalmos, that is to say in which there has been no attempt at formation of an eye, has been recorded.

Microphthalmos is a small eye in which the fœtal ocular cleft has failed to close. A cyst is frequently present in the situation of the ocular cleft, which may result in the formation of an enormous tumour by its subsequent distension.

Cyclops is a condition found in foetal monsters in which the eyes, orbits, and forebrain, are fused, the fronto-nasal process being pushed forward to form a proboscis.

Oxycephaly or "tower" skull is a deformity of the skull and orbits which may lead to marked proptosis and blindness from pressure on the optic nerves.

Proptosis, or pushing forward of the globe, may be due to :—1. Inflammation in the orbit.

(*a*) The result of wounds (orbital cellulitis).

(*b*) Pyæmia.

(*c*) Periostitis.

(*d*) Extension from the nose (suppuration of the ethmoidal sinuses).

2. The presence of foreign bodies in the orbit.

3. Tumours originating within the orbit, e.g.,

(*a*) Tumours of the optic nerve.

(*b*) Nævi.

(*c*) Neuromata.

(*d*) Cysts of the lachrymal gland.

(*e*) Parasitic cysts, e.g. cysticercus.

4. Tumours outside the orbit from the nose and frontal sinus.

5. Vascular disturbances.

(*a*) Thrombosis of the cavernous sinus.

(*b*) Arterio-venous aneurysm.

(*c*) True aneurysm.

6. Hæmorrhage.

(*a*) From perforating wounds.

(*b*) From fractured base of the skull.

7. Emphysema following fractures extending into the nose.

8. Paralysis of all the ocular muscles (loss of tone).

9. Exophthalmic goître.

Enophthalmos may be the result of :—

1. Emaciation.

2. Cicatrices following cellulitis and wounds.

3. Mal-development of the ocular muscles, especially the external rectus.

Injuries.—Fractures of the Orbit may be due to direct or indirect violence. The common injuries are either a gunshot wound or a blow on the side of the head—the latter may be of a comparatively slight nature.

The **symptoms** vary, depending on the portion of the orbit fractured. Thus, when the inner wall is affected the nasal cavity may be opened, causing emphysema. The other signs are hæmorrhage with extravasation of blood into the lids ; blindness, due to rupture of the optic nerve ; and paralysis of one or more of the orbital nerves.

Meningitis is a not infrequent complication of compound fractures.

Treatment.—If a wound is present it should be opened up and rendered as aseptic as possible. Foreign bodies should be removed if easily accessible, for the localisation of which X-Rays may be necessary. The patient should be put to bed and treated as for other fractures of the skull. In cases of emphysema the patient should be warned not to blow the nose.

Pulsating Exophthalmos may be the result of :—

1. Thrombosis of the cavernous sinus (*see* p. 219).

2. The communication of an artery and vein in the orbit.

3. True aneurysmal dilatation of the ophthalmic artery. The most common of these is the communication between the carotid artery and the cavernous sinus—frequently as the result of a blow.

Arterio-venous aneurysm may be spontaneous or traumatic.

Symptoms.—In a spontaneous case the onset is often sudden. The proptosis is well marked and increases rapidly in extent in the traumatic cases. There is a bruit which is heard by both patient and surgeon. The globe can be pressed backwards into a boggy mass. Pressure on the carotid artery usually controls pulsation and the globe may recede. Not infrequently there is paralysis of one or more of the ocular muscles.

Treatment consists in ligature of the common and internal carotid arteries combined with the ligation of the angular vein. The prognosis on the whole is good, especially in the traumatic cases, but some interval should elapse after operation before giving a definite prognosis, as a recurrence is not at all unusual.

Inflammation.—Orbital Cellulitis.—Ætiology.— The commonest causes are wounds, spread of inflammation from the nose (ethmoidal disease), facial erysipelas, periostitis, necrosis of the walls of the orbit, and metastatic pyæmic infection.

Symptoms may be very acute or subacute. There is redness, swelling and œdema of the eyelids with proptosis, the eye being pushed away from the abscess. The general symptoms may be severe or mild.

Treatment.—The great risk in this condition is that the inflammation may spread backwards and cause thrombosis of the cavernous sinus or meningitis. The orbit should be opened up, therefore, as early as possible. In the subacute cases a short delay is permissible if the presence of pus is doubtful. If the patient recovers, the optic nerve may become atrophic, owing to the pressure of the newly formed fibrous tissue.

Tumours of the Orbit arise :—

1. From the orbital tissue.
2. From the eye and spread to the orbit.
3. As metastatic deposits from elsewhere.

1. **Those arising from the orbital tissue** are simple and malignant.

Nœvi may or may not show their presence in the skin of the eyelid. They give rise to proptosis which is increased on bending the head forward or on crying, but no pulsation is present, thus distinguishing the condition from an orbital aneurysm.

The **Treatment** consists in electrolysis. Failing this, provided the condition be increasing, an attempt should be made to excise the nævus. This often results in the loss of the eye while endeavouring to remove the tumour.

Cysts.—Meningocele, cysts in connexion with microphthalmic eyes, dermoid and parasitic cysts, these are all extremely rare.

Osteomata may be single, or multiple as in leontiasis ossium. Where single they are usually of the ivory type.

MALIGNANT.—

Sarcomata.—(1) *Primary* are rare. They usually start in the sheaths of the muscles or blood vessels. They may be round or spindle-celled and are usually of the type known as endotheliomata. They are best treated by removal, after exploration, by Krönlein's method.

(2) *Secondary deposits* from primary growths in the globe. They are usually very malignant and of the melanotic type. They are best treated by evisceration of the orbit, provided there is no evidence of secondary growth elsewhere.

(3) *Metastatic tumours* of the orbit are only to be removed if causing great pain and if the general condition of the patient is fair.

The signs of orbital tumours are :—

1. Proptosis, the eye being pushed away from the main mass of the tumour.

2. Limitation of movement, due to (*a*) mechanical pressure of the tumour ; (*b*) infiltration of the tissue with the growth ; (*c*) the paralysis of one or more of the orbital nerves. In the latter two cases the tumour is probably malignant.

3. It may be possible to feel the tumour with the finger, behind the globe.

4. In cases of doubt an exploratory operation (Krönlein's operation) should be performed and the tumour microscopically examined.

Diagnosis.—The only condition which at first sight may give a superficial resemblance to an orbital tumour is a unilateral exophthalmic goître, which can be excluded by the presence of other symptoms of that disease. (For diagnosis of optic nerve tumours, *see* p. 256.)

CHAPTER XII

OPERATIONS

Ophthalmic operations are divided into two classes :—

1. Intra-ocular. 2. Extra-ocular.

I. INTRA-OCULAR OPERATIONS

Local Preparation of the Patient.—In operating on an eye, the surgeon is brought at once face to face with a great difficulty ; namely, that he is operating in a septic area, since it is practically impossible to render the conjunctival sac aseptic. At the same time in health the conjunctiva has been shown to be sterile in 25 per cent. of cases, pyogenic organisms being found only in 15 per cent., and even then they are not usually of a very virulent character. After the methods of purification given below, these are further considerably reduced in numbers, so that if due precautions are taken the risk of sepsis is small. On the other hand, if conjunctivitis or lachrymal obstruction be present, the risks become enormously increased, especially in the latter condition, unless special precautions are taken. It is, therefore, of the utmost importance that every case should be examined for lachrymal obstruction before operation.

Methods of Purifying the Eye before Operation.—1. Two nights before the operation the eye should be bandaged and examined in the morning for conjunctival discharge. If there be any present an examination for organisms should be made and the operation postponed until the conjunctival condition is improved. In the event of the case being extremely urgent, the conjunctiva should be swabbed over with nitrate of silver (10 grs. to the oz.) immediately previous to the operation. If lachrymal obstruction is present, the sac should be thoroughly washed out with boracic lotion and protargol injected. The puncta may be subsequently occluded by the cautery.

2. The night previous to the operation the lids should be thoroughly cleansed with soap and water followed by 1–2000 solution of perchloride of mercury,

special care being paid to the lid margins and lashes. The eye must then be washed out with boracic lotion and a pad of cyanide gauze be applied covering the field of operation.

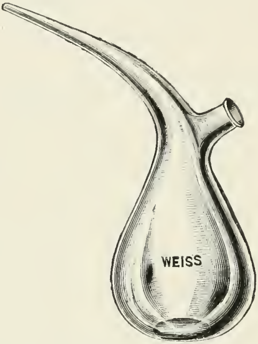


FIG. 93.—Undine for irrigating the conjunctival sac.

3. *Cocaine* and other solutions used both at the time of, and subsequently to operation should be sterilized. To ensure this the solutions should either be boiled immediately before use, or put up in drop bottles made in one piece with a long tapering neck, which is sealed off, and can be broken immediately before use. These bottles can be kept in an aseptic solution so as not to soil the hands of the surgeon.

4. *The hands of the surgeon* are purified and the dressings removed. The patient's head and the area surrounding the operation are covered with sterilized towels. The eyelids are again washed in 1–2000 of perchloride of mercury lotion and the conjunctival sac washed out with a strong stream of boracic lotion by means of an undine which has been kept in a big bowl of boracic lotion, or by an irrigator.

5. *Instruments.*—Non-cutting instruments are boiled for 15 minutes and placed in a tray of 1–80 carbolic lotion. Cutting instruments should be sterilized by dipping them immediately prior to use in pure carbolic for half a minute and then into absolute alcohol in order thoroughly to remove the carbolic. They are then placed in the tray. The greatest care should be taken that cutting instruments and needles should not touch the side of the dish. The edges and points should always be carefully tested immediately before sterilization on a drum covered with fine leather specially made for the purpose.

6. *Dressings.*—A pad of sterilized wool or cyanide

gauze moistened with 1–6000 perchloride of mercury lotion and held in position by a bandage is all that is necessary.

7. *Bandaging.*—The bandage is started on the forehead over the affected eye and is carried in a direction away from the eye to be covered. A complete turn is then carried round the head so as to fix the bandage and the next is brought up beneath the ear and over the eye to be covered. The bandage is then fixed with a pin (Fig. 94).

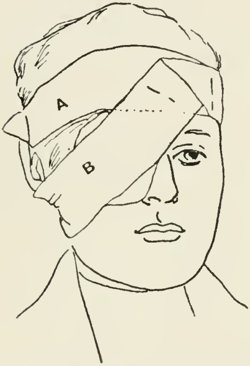


Fig. 94.— An eye bandage. The first turn *A* encircles the head and is fixed with a pin. The turn *B* is then brought up behind the ear.

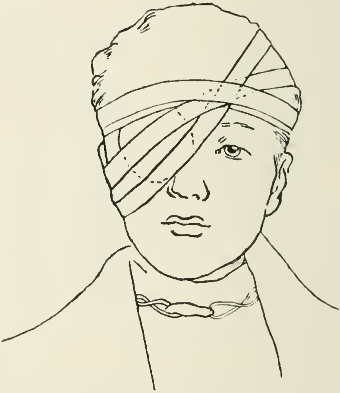


Fig. 95.—A pressure bandage.

Where absolute rest is desired it is necessary to bandage both eyes. After intra-ocular operations this is desirable for the first three days. Where pressure is desired a figure of eight bandage should be used (Fig. 95).

After Treatment.—The eye must be left untouched for twenty-four hours at least. The lids are then cleansed with 1–6,000 perchloride of mercury lotion, and the lower one pulled down so as to allow of the escape of tears and to see whether any discharge is present. The upper lid should not be touched. If no discharge is present the eye is re-dressed. If discharge is present the conjunctival sac should be carefully washed out with boracic lotion. Most wounds with conjunctival flaps are shut off in about forty-eight hours, after which time it is advisable to wash out the conjunctival sac twice a day with boracic lotion. Great care should be taken that no undue pressure is made on the globe. The patient should be warned not to screw up the eyes or strain whilst the dressing is being carried out.

General Preparation.—1. **The Urine** should always be examined, especially in cases of cataract, as not infrequently this disease is associated with diabetes, and it is often advisable to treat the general condition before operation.

2. **The Bowels** should be opened by an aperient the night before the operation, as it is desirable to keep them confined for the first two days in order to avoid straining. They should subsequently be evacuated in the supine position.

3. **The Time** to choose for operating, if possible, should be the morning, since the light is then best and the patient has had a night's rest and is less likely to lose self-control. Usually there is some pain after the effect of the cocaine has passed off, and this the patient is better able to endure in the daytime.

4. **Anæsthetics.**—A general anæsthetic should be given to all patients with congested eyes, small children, patients who are deaf, and patients who show a want of moral control. It is best to use chloroform for all intra-ocular operations, which must be administered to the full degree of anæsthesia.

Local anæsthesia is obtained by the use of 4 per cent. solution of cocaine instilled four or five times at intervals of three minutes before the operation. Adrenalin (1–2,000) may be used with advantage in conjunction with the cocaine.

5. **After the Operation** a patient should lie, if possible, on his back. If he be unable to obtain sleep in this position, it is better that he should lie on the unoperated side than remain without rest. A clove hitch can be placed round the wrist belonging to the operated side, and fastened to the bed, in order to prevent interference with the eye during sleep.

OPERATIONS: **Extraction of the Lens.**

Indications.—1. Hard cataract. 2. Displacements of the lens. 3. High myopia. 4. A foreign body in the lens.

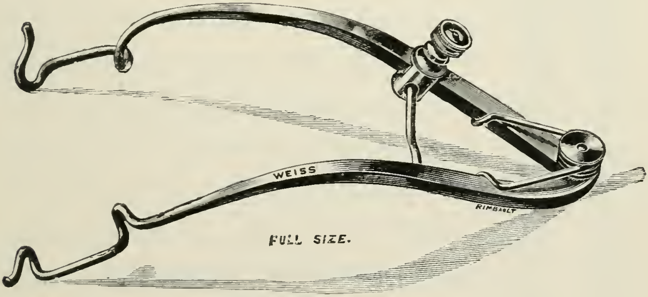


FIG. 96.—Eye speculum.

Cataract Operation.—*Instruments.*—Speculum (Fig. 96), two pairs of fixation forceps (Fig. 97), a Graefe's knife, iris forceps, iris scissors, capsule forceps, cystotome, curette or spoon, iris spatula, vectis.

The operation is divided into five stages—

1. Incision.
2. Iridectomy.
3. Opening of the lens capsule.
4. Delivery of the lens.
5. Toilette of the wound.

1. *Incision.*—The surgeon, standing behind the patient's head and holding the knife (Fig. 98) with the edge directed upwards, in the right hand for the right eye and the left hand for the left, fixes the eye with a pair of forceps held in the other hand, by grasping the conjunctiva below and to the inner side as close to the limbus as possible. The point of the knife is then passed on the

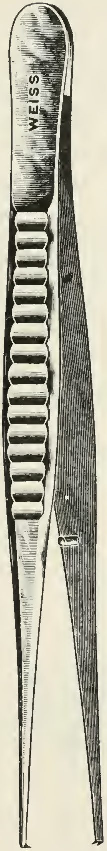


Fig. 97.—Fixation forceps.

flat into the anterior chamber from the outer side, 1.5 mm. behind the corneo-scleral junction. It is first directed downwards and inwards until the chamber is penetrated. The knife is then passed across the anterior chamber in a line parallel with an imaginary tangential line across the top of the cornea. The counter puncture is then made, the knife emerging 1 mm. behind the corneo-scleral junction. The incision is made by means of a sawing movement so that a flap is formed of corneal tissue about 3 mm. in breadth (one and a half breadths of the new Graefe knife) attached to which should be a flap of conjunctival tissue.

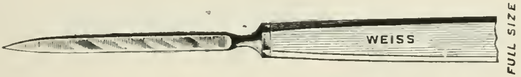


FIG. 98.—Graefe knife.

2. *Iridectomy.*—The patient is directed to look downwards. A pair of iris forceps is inserted closed into the anterior chamber, then opened, the iris grasped near its root, and withdrawn. A piece of iris is then removed with the scissors, being divided as close to the eye as possible.

3. *The capsule of the lens is opened* (*a*) by means of capsule forceps (Fig. 99) which are inserted closed, and when in position over the lens are opened as widely as possible without entangling the iris, then pressed down on to the anterior capsule of the lens and closed ; in this manner the portion of the capsule thus included is removed by a slight lateral movement ; (*b*) by means of a cystotome, the lens capsule being opened by a triangular incision ; (*c*) by the point of the knife as it passes across the anterior chamber. When the capsule of the lens is opened properly the lens is usually seen to come forward. The advantage of the capsule forceps over the two other methods is that many of the cases do not require a subsequent needling.

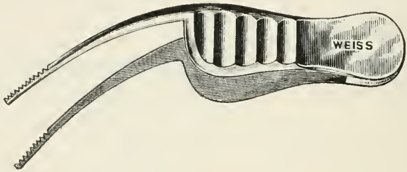


Fig. 99.—Capsule forceps.

4. *Delivery of the lens* is performed by gentle pressure, combined with massage, on the lower

margin of the cornea with a curette or spoon. Delivery of the lens may be prevented by (*a*) an imperfect opening in the capsule ; (*b*) too small an incision ; (*c*) a sticky consistency of the lens cortex. If vitreous should present before the nucleus is delivered, the latter should be removed by means of the vectis, which must be passed behind the lens nucleus and withdrawn (Fig. 100).

5. *Toilette of the wound.*—All soft matter should be removed by expression as far as possible. The angles of the coloboma in the iris should be replaced by means of the spatula, which ought also to be passed throughout the extent of the wound in order to free it from any capsule which may have become prolapsed in it. The conjunctival flap is then placed in position and the eye bandaged, atropine being instilled either at the time of operation or at the first dressing.

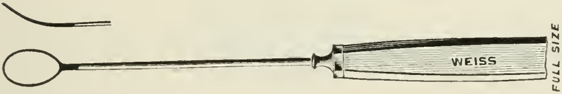


Fig. 100.—Vectis.

Modifications.—*The incision* may be made somewhat smaller if a small nucleus is expected (young patient or hypermature cataract).

The iridectomy may be (*a*) omitted; although this leaves the patient without the deformity of a coloboma it is a source of danger, owing to the liability of the iris to prolapse into the wound.

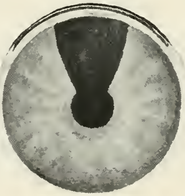


FIG. 101.—Incision and iridectomy for cataract.

Under these circumstances the wound should be examined twelve hours after the operation, and an iridectomy performed if there is any sign of prolapse. (*b*) The iridectomy may be performed at a previous operation (preliminary iridectomy) (Fig. 101). It has the advantages that the surgeon learns how the patient will behave during an operation, and how the eye will react to any interference. There is an absence of bleeding at the second operation which makes it easier. There is less liability for the iris to become subsequently adherent to the capsule. The disadvantages (which seem to outweigh the advantages), are that there is a double chance of sepsis, and that the patient has to submit to two operations when one ought to be sufficient. When a preliminary iridectomy is performed a keratome may be substituted for the Graefe knife in making the incision.

Removal of the lens in its capsule is an operation much practised in India, although not generally in vogue in this country.

Discission or Needling.—*Indications.*—1. For tearing holes in capsular membranes left after cataract extraction. 2. For opening the lens capsule and breaking up the lens substance to promote absorption of a soft cataract or the lens in a case of high myopia in a young patient.

Instruments.—Speculum, fixation forceps, two needles (one with a long cutting edge and one with a short edge (Fig. 102). As a rule only one is required, except in the case of dense membranes.

Operation.—The pupil should be previously dilated with atropine. The speculum is inserted and the eye fixed by means of forceps. The needle is passed into the anterior chamber about 1 mm. behind the corneo-scleral junction, in the most convenient situation and passed through the membrane as low down as possible. The cut in the membrane is made at right angles to the course of its fibres, using the cornea as a fulcrum on which to rotate the needle. When a hole is obtained, the needle should be withdrawn on the same plane in which it is inserted. This is best done by keeping the maker's name upwards, both on insertion and on withdrawal.

FIG. 102 Discission needle.

If a lens is being needled for its removal, after opening the capsule the lens fibres should be broken up by a stirring movement. After such an operation as the above the lens will become opaque, swell up, and the soft matter come forward into the anterior chamber. Occasionally, after such an operation, the tension of the eye becomes raised. It is then desirable to perform an *evacuation* of this soft matter by means of a curette through an incision at the limbus previously made with a keratome (Fig. 103). Subsequently, the eye may require another needling for the opaque capsule which is usually left.

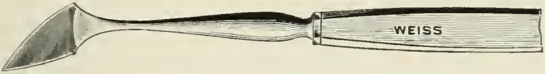


FIG. 103.—Keratome.

Iridotomy.—*Indications.*—Iridotomy is an operation which is performed when the iris has become drawn up after a cataract extraction, so that there is no pupil, or when the pupillary area is covered by the upper lid. Many operations have been devised for this most troublesome condition, but the following is one which I have found in my experience to be the most successful. A long interval should have elapsed between the extraction and the iridotomy, since these cases have usually suffered from cyclitis following the operation.

Instruments.—Speculum, fixation forceps, a long narrow, bent, broad needle ; Tyrell's hook, iris scissors, iris forceps and spatula.

The bent broad needle is passed into the anterior chamber from the limbus downwards and inwards, and is driven directly through the underlying iris and capsule. The needle is then made to pass in an upward direction into the pupillary area above, or if no pupil is present again through the iris. The bent broad needle is made to cut laterally so as to produce a band of iris and capsule. The knife is then withdrawn, and a Tyrell's hook passed beneath the band, which is drawn into the wound and removed with scissors. A large opening with a minimum amount of damage is thus obtained. If the hook should slip the band may be seized with iris forceps and removed.

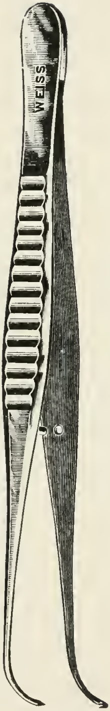
Operations for Glaucoma.

Iridectomy.—*Indications.*—1. In all cases of acute glaucoma where the patient has perception of light. 2. In all cases of chronic glaucoma where the disease is not controlled by eserine.

Instruments.—Speculum, two pairs fixation forceps, a narrow Graefe knife, iris forceps, iris scissors and spatula.

Incision.—The surgeon, standing as for a cataract extraction, enters the knife slightly further back (2 mm.) behind the corneo-scleral junction. Directly the point of the knife appears in the anterior chamber the point is directed upwards and carried across the anterior chamber near its periphery, keeping superficial to the iris, so as to avoid wounding the lens. The counter puncture is then made and the knife made to cut out, forming a conjunctival flap. The iris forceps (Fig. 104) are then inserted closed at the right-hand angle of the incision, opened, and the iris grasped near the periphery and pulled into the wound so as to produce an iridodialysis. The iris is then removed by first cutting one side, withdrawing the iris as far as possible and after tearing it across to the other angle of the wound, is divided, resulting in a wide iridectomy (Fig. 106). The angles of the coloboma are replaced and the conjunctival flap placed in position.

Modifications.—A keratome is occasionally used instead of a Graefe knife ; but on the whole it is not



FULL SIZE.

Fig. 104.—Iris forceps.

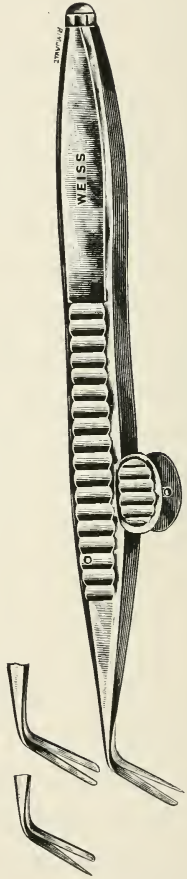


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Fig. 105.—Iris scissors.

so satisfactory, as the former instrument gives a more shelving incision, with the result that the iris cannot be removed so near its attachment to the ciliary body. The wound is smoother and more regular, so that a leak in the scar is less liable to form than with a Graefe knife.

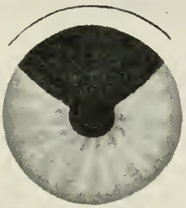

FIG. 106.—Incision and iridectomy for glaucoma.

Sclerotomy. — *Indications.* — This operation is especially useful in cases where iridectomy has failed to relieve the tension of a glaucomatous eye.

Instruments.—Speculum, two pairs fixation forceps, Graefe knife, iris spatula.

The Graefe knife is inserted into the anterior chamber as for the incision for a glaucoma iridectomy, and the counter puncture is made. In the complete operation the knife is made to cut out, leaving only a conjunctival bridge in the upper part of the wound. In the incomplete operation a band of sclerotic is left. If the iris should prolapse it must be replaced with the spatula.

Posterior Sclerotomy or Scleral Puncture.—*Indications.*—1. In emergency in acute glaucoma whilst waiting for iridectomy. 2. In some cases of acute glaucoma, where the chamber is extremely shallow, a posterior scleral puncture will allow the formation of a better anterior chamber, and facilitate the performance of an iridectomy. 3. To allow the fluid to escape from behind a retinal detachment.

Instruments.—Speculum, Graefe knife, forceps.

The patient is made to look inwards. The conjunctiva is seized on the outer side, near the limbus, and drawn slightly downwards. The Graefe knife is passed through the sclerotic, well behind the ciliary region, turned to a right angle, and withdrawn. A bead of vitreous matter usually presents, and the conjunctiva is then allowed to go back into its place so that a valve-like opening is formed.

Optical Iridectomy.—*Indications.*—1. Opacities of the cornea occupying the pupillary area. 2. In rare instances in cases of lamellar cataract (Fig. 107).

Instruments.—Speculum, fixation forceps; bent broad needle, Tyrell's hook, iris forceps, scissors and spatula. The site of election for the operation is opposite a clear portion of the cornea, i.e. away from the opacity, and when possible should be downwards and inwards. The incision is made with the bent broad needle just at the limbus. Tyrell's hook, or iris forceps, is inserted and the pupillary margin of the iris withdrawn. As small a piece as possible is then removed with forceps, and the iris replaced by means of a spatula.

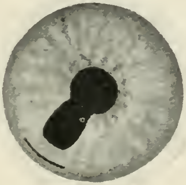

FIG. 107.—Incision and iridectomy for optical purposes.

Conical Cornea.—Flattening of the conical cornea may be produced either by cauterizing the apex of the cone, which is very thin in this position, or by excision of a small piece of the cornea at its apex. This is performed by transfixion and subsequent removal of the flap (*see* also p. 145).

II. EXTRA-OCULAR OPERATIONS.

Enucleation and Allied Operations.

Enucleation.—*Indications.*—Enucleation should be undertaken in preference to its substitutes, except (1) in cases of suppurating eyes, which should be eviscerated, (2) in the case of children it is best, if possible, to substitute Mules' or Frost's operation. as the presence of an artificial globe in the orbit probably promotes better development of that structure.

Instruments.—Speculum, fixation forceps, a pair of straight scissors, squint hook, pair of big curved scissors, needle holder, needle and silk.

The straight scissors, held by means of the thumb and ring finger, are made to divide the conjunctiva all round close to the cornea. Tenon's capsule is then opened, and the strabismus hook is passed under each of the four recti in turn, which are divided between the hook and the globe. The eye is then dislocated between the lids by opening and pressing backwards the speculum. The large curved scissors (Fig. 108) are passed behind the globe from the inner side and the nerve felt as a firm cord. The scissors are then opened and the nerve divided. The attachments of the obliques are divided close to the globe, which is then removed. After the hæmorrhage has ceased, a running stitch without a knot should be inserted so as to bring the upper and lower edges of the conjunctival wound to-

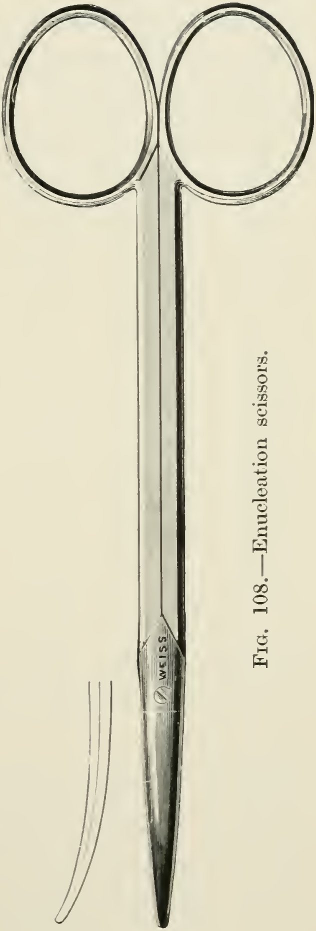

Fig. 108.—Enucleation scissors.

gether, the ends being left long so as to facilitate removal at the end of the first week. The socket should be kept cleansed with a boracic lotion. An artificial eye, which is only worn in the daytime, may be used after about six weeks.

Evisceration.—*Indications.*—It is the ideal operation for panophthalmitis, since by its performance the dural sheath of the optic nerve is not opened up, and the risk of meningitis is avoided.

Instruments.—Speculum, fixation forceps, Beer's knife, straight scissors, scoop, flushing apparatus.

The cornea is removed by cutting a flap by transfixion with Beer's knife, and then finishing the removal by means of scissors. The contents of the globe are then evacuated by means of a scoop, and it is washed out with the flushing apparatus. No trace of the uveal tract should remain. The sclerotic is then allowed to fall together and a pad and bandage applied.

Mules' Operation.—*Indications.*—Where a very moveable stump is desired. It is the ideal operation for children with staphylomatous cornea as the result of ophthalmia neonatorum. At one time it fell into disrepute owing to some cases of sympathetic ophthalmia having been reported following it, but in these cases portions of the uveal tract had been left. It is, therefore, of the utmost importance that the contents of the globe should be entirely removed.

Instruments.—As for evisceration, a glass globe, three stitches, curved needles.

The operation is similar to evisceration, but instead of allowing the sclerotic to collapse a glass or celluloid globe is inserted and the wound closed by means of sutures. The globe should fit loosely in the cavity. The reaction after the operation is often severe, and is best controlled by means of the application of cold.

Frost's Operation is the same as for enucleation, the glass globe being inserted into the capsule of Tenon, and the conjunctiva being closed over it by means of sutures.

Operations on the Extra-ocular Muscles are most frequently undertaken for squint, either—

(1) For cosmetic reasons, to remedy a deformity due to a squinting eye which is amblyopic.

(2) To rectify the muscular equilibrium in such cases as alternating or latent squints. When the operation is performed for the latter reason the adjustment will naturally have to be much more accurate than for the former.

The muscular balance is interfered with by the administration of a general anæsthetic. It is, therefore, desirable that operations on the ocular muscles should be performed under adrenalin and cocaine. This is usually possible, except in the case of very small children.

The tendons of the recti muscles are inserted into the globe at the following distances from the corneo-scleral junction : internal, 5 mm. ; inferior, 6 mm. ; external, 7 mm. ; superior, 8 mm. Besides the tendinous insertions the muscles are held in place by fascial expansions on either side of the tendon. Division of these expansions allows a greater retraction of the muscle and is, therefore, to be undertaken when a greater degree of squint has to be overcome. On the other hand, if too freely performed there is the danger that the muscle may not regain a proper attachment to the globe, and it is, therefore, better in high degrees of squint (over 20° of convergence), and in all cases of constant divergence, to combine tenotomy with advancement. In cases of latent convergent strabismus, of about 12° prism (Maddox test) division of the tendon of the internal rectus only, without the expansion, will usually rectify. Cases of latent divergent strabismus of about 8° prism (Maddox test) require complete division of the tendon of the external rectus, and in some cases of the expansions as well. In these cases it is most important that the patient should be tested with the Maddox rod during the operation.

Tenotomy.—*Instruments.*—Speculum, straight and blunt-pointed scissors, strabismus hook (Fig. 109), needle and silk, needle holder. Tenotomy may be performed (1) by the open method, (2) subconjunctivally.

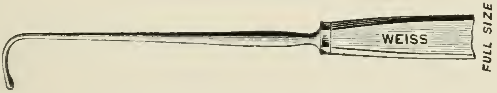

Fig. 109.—Strabismus hook.

1. **Open Method.**—The conjunctiva is divided freely directly over the insertion of the tendon into

the globe, and dissected backwards. The tendon of the muscle is then seized in fixation forceps and button-holed as close to the globe as possible. The lower blade is then passed through the hole in the tendon, and the rest of the tendon and expansion divided up and down to the extent required to bring the eye straight to appearance or the Maddox rod test. The conjunctiva is then brought together with a fine suture. All pulling on the muscle with a hook should be avoided, as it is painful and disturbs the muscular equilibrium.

2. **The Sub-conjunctival Method** is unsatisfactory, since it is impossible to say with certainty whether the whole of the tendon, and especially the expansion, is divided. It is painful, and is sometimes followed by a troublesome hæmorrhage into the capsule of Tenon. Occasionally it may be of use in some cases of amblyopic eyes where a small wound is desirable. The conjunctiva is button-holed below the tendon, and separated from its surface. The capsule of Tenon is then opened, and a strabismus hook passed beneath the tendon, which is divided between the hook and the globe.

Advancement.—Of the many operations that have been devised the following is the one probably most frequently in use.

Instruments.—Speculum, straight scissors, fixation forceps, strabismus hook, Prince's forceps (Fig 110), four sharp needles and silk, needle holder.

The conjunctiva over the muscle to be advanced is freely divided and dissected back. The capsule of Tenon is then button-holed by a small incision well away from the tendon. A tenotomy hook is passed beneath the tendon and brought out through a small hole in Tenon's capsule above. The smooth blade of the Prince's forceps is then inserted in place of the hook, and the tendon, together with its expansions, grasped between the blades. Tenotomy of the opposing muscle is then performed. The muscle to be advanced and its

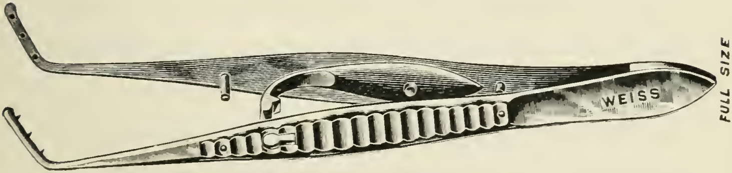

FIG. 110.—Advancement forceps.

expansion, which is clamped between the blades, is then separated from the globe. Three strong silk sutures, an upper, lower and middle, are passed through the conjunctival and episcleral tissue on the corneal side of the wound and as far back as possible into the muscle and through the cut margin of the conjunctiva on the other side of the wound. The middle suture should be first tightened to the required extent to bring the eye straight. The upper and lower are then tied. It is most important that a good hold be taken in the episcleral tissue, and it is, therefore, important that very sharp needles should be used. It is advisable to tie up both eyes for the first four days after all muscular operations, more especially when an attempt is made to regain binocular vision. Atropine in both eyes is desirable, especially when there is any tendency to convergence. Glasses should be worn on uncovering the eyes.

Operations for Ptosis.—The following operations are usually only undertaken for the congenital form, but may rarely be required for the paralytic variety. All operations are far from satisfactory, and should only be undertaken where the lid completely or partially covers the pupil. Of these there are two main types which aim at—

(1) The attachment of the lid to the occipito-frontalis muscle.

(2) The advancement of the levator palpebræ muscle.

Unfortunately this muscle is often completely absent in the congenital form. Attempts have been made to use portions or the whole of the superior rectus in its place, but not infrequently this muscle also is absent or very defective.

1. **The Attachment of the Lid to the Occipito-Frontalis Muscle.—Hess' Operation.**—*Instruments.*—Scalpel, dissecting forceps, needle and holder, spatula, artery forceps.

The eyebrow having been shaved, an incision is made about two inches long in the line of the brow, and the skin dissected down almost to the lid margin. Three sutures are passed, one in the middle, and one at the outer and inner end of the lid. The sutures should be doubly armed with needles. Each needle is inserted in the lid margin and out into the wound, so that the lid margin is held by a loop. These threads are then carried deeply beneath the upper edge of the wound into the substance of the occipito-frontalis muscle, and brought out through the skin, and tied over a piece of drainage tube. These sutures inserted in this manner pull up the lid; the amount of retraction should be considerably overdone, as the lid subsequently tends to drop again. The skin wound is then closed. The deep sutures should be left in for at least three or four weeks, so that by their irritation they may bring about a fibrous band between the muscle and the eyelid.

Panas' Operation.—(Fig. 111). In this operation a direct adhesion of the skin of the lid to the occipito-frontalis muscle is aimed at.

Instruments.—As for the previous operation.

An incision, two inches long, is made in the line of the brow, and an incision of a similar length is made into the skin of the lid below it. The tissue between these two incisions is converted into a band of skin and subcutaneous tissue attached at either end. Two vertical incisions are made into the lid, running slightly outwards and inwards respectively, towards the outer and inner canthus. These incisions join the lower margin of the lower wound. The flap thus produced is raised, and doubly armed sutures are passed through its upper end, and are carried beneath the band of skin and subcutaneous tissue. The needles are then carried deeply into the substance of the occipito-frontalis muscle through the upper margin of the wound, brought out on the forehead, and tied over pieces of drainage tube. The rest of the wound is then closed with sutures.

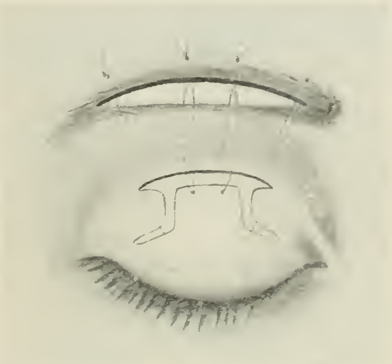

FIG. 111.—Panas' operation for ptosis.

The two middle sutures attach the flap of skin to the occipito-frontalis. The outer and inner sutures hold the lid in position during cicatrization.

2. **The Advancement of the Levator Palpebræ.**—The tendon of the muscle is exposed at the upper tarsal

margin. The tendon lies directly beneath the superior palpebral ligament, which can be distinguished from it by the fact that when pulled on it does not stretch. The tarsal plate is then freely exposed and the muscle shortened, either by (*a*) stitching the muscle to the anterior surface of the tarsus, (*b*) bringing the tendon through a hole in the tarsal plate and suturing it there, or (*c*) folding the tendon on itself. The wound is then closed. The lid may also be shortened by removing a piece of skin and orbicularis muscle. The difficulty of the operation is in finding the levator palpebræ muscle, which is usually very imperfectly developed.

Operations for Entropion and Trichiasis.

Skin and Muscle Operation.—*Indications.*—Especially suitable for senile or spastic entropion of the lower lid, which cannot be kept in place by the use of collodion. With scissors and forceps a strip of skin and orbicularis muscle is removed from the lower lid and the wound closed with sutures.

Electrolysis.—*Indications.*—In the case of a few eyelashes turning in on to the cornea or conjunctiva, they may be removed by passing a blunt platinum needle alongside the lashes into, and not through, the hair follicles and allowing a constant current of about four volts to pass. If properly performed the lash will fall out when touched (Fig. 112).

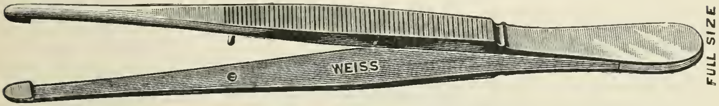

FIG. 112.—Epilation forceps.

Arlt's Operation.—(Fig. 113) *Indications.*—Where a part or the whole of the lashes of the upper lid turn inwards.

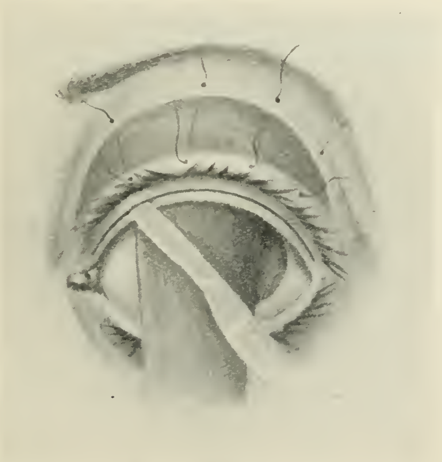

FIG. 113.—Arlt's operation for trichiasis.

Instruments.—Beer's knife, forceps, scissors, sutures and holder, lid clamp (Fig. 114).

A lid clamp is inserted into the upper conjunctival sac. The lid margin and tarsal plate are split behind the lash bearing area. An incision through the outer surface of the lid is made to meet the other at right angles, so that the lashes are carried on a band of tissue attached at either end. An elliptical piece of skin is then removed by a curved incision above the last, and the band carrying the lashes is stitched to the upper margin of the wound.

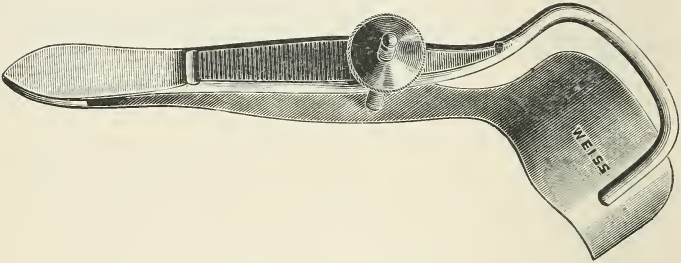

Fig. 114.—Lid clamp.

Operations for Ectropion.—Ectropion usually affects the lower lid. In addition to the deformity of eversion there is usually some lengthening of the lid margin, and thickening of the exposed conjunctiva to be overcome.

Slitting the Canaliculi.—*Indications.*—(1) In slight degrees of ectropion, not infrequent in old people, in which the puncta are not properly applied to the globe and which cannot be properly remedied by the use of astringent lotions. (2) Preparatory to one of the following operations.

Instruments.—Straight iris forceps, scissors, Nettleship's canaliculus dilator and Weber's canaliculus knife (Fig. 115).

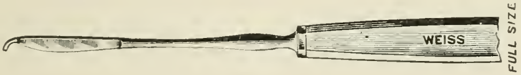

Fig. 115.—Canaliculus knife.

The punctum should be dilated and a Weber's knife passed into the canaliculus which should be split inwards for about half its length, the posterior lip of the incision being removed with a pair of forceps and scissors.

Snellen's Sutures.—(Fig. 116). *Indications.*—Especially useful in moderate degrees of the senile form of ectropion, in which there is not much thickening of the lid margins. Each suture should have a needle at both ends. The needles are passed in, about 3 mm. apart from the conjunctival surface at the apex of the everted lid, and after passing deeply through the tissues brought out again on the cheek low down and tied together over a piece of drainage tube. The loops, when tightened, draw the lid inwards and they should be left in place some three or four weeks. The operation gives rise to much subsequent pain and discomfort, and the deformity is usually better

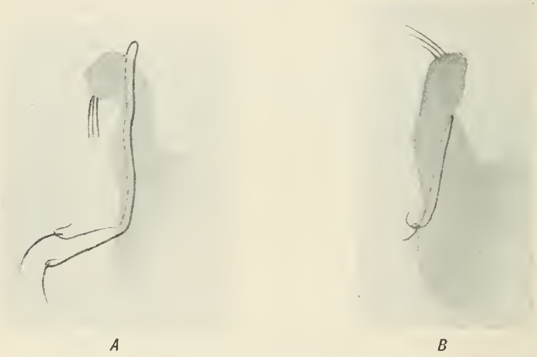

Fig. 116.—Snellen's sutures.

A. A suture in position.
B. After tightening.

remedied by the following operation, which is also useful for cases consequent on severe blepharitis in which there is considerable thickening of the lid margin.

A strip of thickened conjunctiva and sub-conjunctival tissue, corresponding to the apex of the eversion, is removed along the whole length of the lid. The wound produced is united with sutures, the pull of the conjunctiva being sufficient to draw the lid inwards. If it is insufficient the upper and lower lids may be united by making small raw surfaces at the margins opposite to each other, and suturing them together. They should remain united from six weeks to three months (tarsorrhaphy). The method is also a useful adjunct to the following operation.

The " VY " Operation is especially useful for cases of ectropion due to scar tissue, such as would result from tuberculous periostitis of the lower orbital margin.

Instruments.—Scalpel, dissecting forceps, artery forceps, sutures.

A V-shaped incision is made, apex downwards, to include the whole line of the lower lid. The incision includes the skin and subcutaneous tissue. The V-shaped flap is dissected up and the lid liberated from the underlying scar tissue. The incision is then sewn up so as to form a Y. It is usually desirable to unite the lids temporarily. Shortening of the lid margin may be subsequently desirable by removal of a small V-shaped portion through its whole thickness.

In cases of severe cicatricial contraction and loss of substance, such as sometimes affect the upper and lower lids after severe degrees of burns, the best method of treatment is to transplant flaps from the forehead or elsewhere, or by the division of cicatricial bands with subsequent skin grafting.

Canthorrhaphy is the permanent union of the lids together at the outer canthus. It is useful in some cases of ectropion, in addition to other operations, and more especially in a condition known as lagophthalmos, or ectropion of the lower lid, due to paralysis of the seventh nerve, and in cases of exophthalmos where the globe is not covered by the lids.

The lid margins for about 6 mm. at the outer canthus are split. A triangular area with its base formed by this incision is removed from the under surface of the upper lid, and a similar area from the outer surface of the lower lid carrying the eyelashes ; the raw surfaces are brought into apposition and fixed by a suture passed through the whole thickness of the lid.

Tarsorraphy is the union of the lids at their margins. Complete union is performed when an artificial eye cannot be worn ; partial union for cases of trophic corneal ulceration, and in cases of ectropion operations when it is desired to keep the lid in position during the process of cicatrization. The lid margins behind the eyelashes are denuded of epithelium and sutured together. As narrow a strip of this as possible should be removed.

Canthotomy is the division of the outer canthus with scissors, and is useful in some cases of severe blepharospasm associated with a fissure at the outer canthus.

Canthoplasty is useful when it is desired to enlarge the palpebral aperture. The canthus is divided as before, the conjunctiva being stitched into the wound made.

Operations on the Conjunctiva.

Pterygium.—*Indications.*—When the pterygium is spreading across the cornea, or when very unsightly.

Instruments.—Speculum, scissors and forceps, stitch.

The base of the pterygium is divided and dissected up to the cornea. The head and neck is then stripped from the cornea by a sharp pull. The wound must be carefully stitched together or the disease will recur.

Symblepharon.—The adhesion of the lid to the globe is divided and the raw surfaces covered with flaps from the conjunctiva or by means of skin or grafting of the mucous membrane.

Peritomy.—*Indications.* — Occasionally performed for superficial vascular opacities in the cornea (e.g. pannus).

A band of conjunctiva and episcleral tissue is removed with scissors and forceps as close to the cornea as possible, opposite the vascular opacity. The wound is left to granulate.

Operations on the Lachrymal Apparatus.

Dilatation and Slitting of the Puncta has already been described (*see* ectropion).

When syringing and probing have failed to cure lachrymal obstruction one of the following operations for the obliteration of the lachrymal apparatus may be employed.

Obliteration of the Canaliculi.—*Indication.*—In cases of lachrymal obstruction in which there is no mucocele.

A fine cautery is passed into both canaliculi and the epithelium destroyed.

Excision of the Lachrymal Sac.—*Indications.*—(1) For mucocele which has failed to yield to treatment; (2) in all cases of tuberculous disease; (3) for a recurrent lachrymal abscess; (4) for hypopyon ulcer associated with lachrymal obstruction; (5) before operation on the globe; (6) for lachrymal fistula.

Instruments.—Small scalpel, forceps, Muller's speculum (Fig. 117), Axenfeld's speculum (Fig. 118), straight scissors.

The internal tarsal ligament is first defined by put-

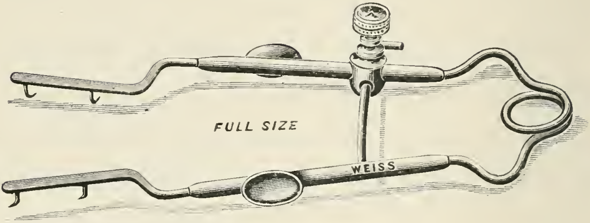

FIG. 117.—Muller's retractor for excision of the lachrymal sac.

ting the lids on the stretch. An incision should be made, 3 cm. in length (one cm. of which should fall above the tarsal ligament), directly over the lachrymal sac. Muller's speculum is then inserted

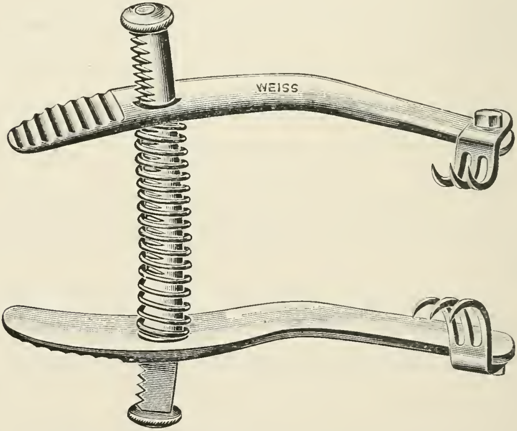

FIG. 118.—Axenfeld's retractor for excision of lachrymal sac,

laterally to the wound. The tarsal ligament is exposed and divided, the lachrymal sac being found directly beneath it. The sac wall is then separated from the surrounding structures, first internally and then externally, the canaliculi being divided. Axenfeld's speculum is then inserted in the longitudinal axis of the wound. Having defined and detached the top of the sac, the posterior wall is separated, and the neck of the sac divided as far down the duct as possible by means of scissors. Some operators remove the periosteum of the lachrymal bone as well as the sac, but this is unnecessary. The hæmorrhage is the most troublesome part of the operation and is best controlled by injecting adrenalin (made from the dried gland) and cocaine into the sac half an hour before and into the skin immediately before operating. Swabs on the end of glass rods dipped in adrenalin and cocaine may also be used.

Excision of the Lachrymal Gland.—*Indications.*—(1) For cysts and tumours; (2) for obstinate epiphora following excision of the lachrymal sac; for the latter condition the palpebral portion only is generally removed.

Removal of the Palpebral Portion.—The upper lid is everted and the gland seen beneath the conjunctiva is seized with forceps and drawn forward. A horizontal incision is made through the conjunctiva immediately above the forceps, and into this is passed a sharp hook with which the gland is drawn into the wound. By means of a blunt-pointed pair of scissors the gland is separated from its attachments and the wound in the conjunctiva subsequently closed with sutures.

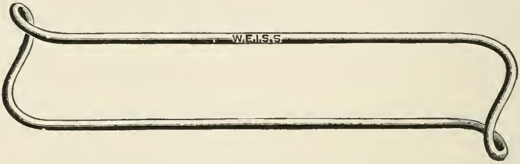

Fig. 119.—Eyelid retractor.

Removal of the Orbital Portion of the Lachrymal Gland.—An incision is made through the skin along the upper and outer third of the orbital margin. The structures are divided down to the gland lying in the depression in the orbital roof. The gland is first separated from the periosteum and then carefully removed from the lid.

Operations on the Orbit.

Evisceration of the Orbit is always performed for some form of new growth. It may be modified according to the nature of the growth. In severe cases of rodent ulcer and sarcomatous growths, which involve the lids, it is desirable that the lids should be removed with them, but in cases of optic nerve tumour or in diseases situated far back in the orbit, the lids and conjunctiva may be retained, since a much better socket is thus obtained.

Complete Evisceration of the Orbit.—An incision completely encircling the orbital margin down to the bone is first made. The periosteum is then separated completely as far back to the optic foramen as possible, the apex divided by means of curved scissors and the whole orbital contents thus removed. The wound is packed and skin grafting of the orbit at a subsequent operation is usually performed to promote healing.

The Incomplete Method.—The globe is first enucleated. The outer canthus is divided together with the conjunctiva. The lids are well retracted and an incision is carried down to the bone encircling the orbit. The periosteum is then stripped up and the apex of the cone divided as far back as possible. The conjunctiva and outer canthus are then united with sutures.

Krönlein's Operation is performed for exploration and removal of tumours of the orbit leaving the globe in situ. It is especially suitable for non-malignant tumours of the optic nerve. An incision over the outer margin of the orbit is carried down to the bone and the periosteum separated from the outer wall of the orbit on its inner surface. The finger is then inserted and the tumour felt. Occasionally tumours can be removed through this incision without further enlarging the wound. Failing this the bone is divided above and below by means of an osteotome or saw, the upper incision dividing the base of the external angular process of the frontal bone, and the lower running downwards and backwards into the spheno-maxillary fissure. The bone attached to the flap is then forced outwards. Next, the periosteum of the orbit is divided horizontally, the finger introduced, and the tumour removed. The flap is then replaced in position by sutures and the wound closed. The operation is liable to be followed by great proptosis as the result of hæmorrhage into the orbit, ulceration of the cornea, due to its anæsthesia, and defective movements of the globe in consequence of adhesion of the external rectus to the scar.

APPENDIX

CALMETTE'S OPHTHALMO-TUBERCULIN REACTION

Calmette has recently shown that by dropping a solution of 1–100 of glycerine-free tuberculin into the conjunctival sac of a patient suffering from tuberculosis (however small the lesion), an acute conjunctivitis, varying from a slight redness of the caruncle up to a severe purulent ophthalmia, comes on in about six hours, and lasts for about four days.

The disadvantages of the test are that so many people may have an obsolete focus of tubercle, such as a mediastinal gland, and the disease from which they are suffering may not be of tuberculous origin. The reaction in a few cases known to be tubercular has been so mild that they might have been overlooked unless carefully examined by an experienced observer. In children the reaction is often very severe; it is advisable in them to use a solution of 1–200 of tuberculin.

PRESCRIPTIONS FREQUENTLY USED IN OPHTHALMIC MEDICINE

Guttæ

Guttæ adrenalin . . . . . 1 in 1,000

Stronger solutions may be made by boiling the dried gland with water.

Guttæ atropinæ.

℞	Atropinæ sulphatis	gr. 4
	Aq. dest.	ad fl. oz. 1

Guttæ atropinæ cum cocainâ.

℞	Atropinæ sulphatis	gr. 2 ad gr. 4
	Cocain. hydrochlor.	gr. 10
	Aq. destillat.	fl. oz. 1

Misce.

Produces greater effect than atropine alone in some cases of iritis.

Guttæ dionine.

℞	Dionine	2 % solution

Guttæ cocainæ hydrochloratis.

℞	Cocain. hydrochlor.	gr. 4 ad gr 8
	Aq. destillat	fl. oz. 1

Misce.

For operations and for the removal of foreign bodies.

Guttæ eserin.

℞	Eseriæ sulphatis	gr. ½ ad gr. 2
	Aq. destillat	fl. oz. 1

Misce.

Guttæ homatropinæ cum cocainâ.

℞	Homatrop. hydrobrom.	gr. 4
	Cocain. hydrochlor.	gr. 10
	Aq. destillat.	fl. oz. 1

Misce.

For dilatation of the pupil and refraction. The effect lasts usually about twelve hours.

Guttæ hyoscinæ.

℞	Hyoscinæ hydrobom.	gr. 2
	Aq. destillat.	fl. oz. 1
	Misce.	

Useful when atropine causes irritation.

Guttæ pilocarpinæ.

℞	Pilocarpinæ nitratis	gr. 2
	Aq. destillat.	fl. oz. 1
	Misce.	

Guttæ zinci chloridi.

℞	Zinci chloridi	gr. 1 ad gr. 3
	Aq. destillat.	fl. oz. 1
	Misce.	

Useful in lachrymal obstruction.

Guttæ zinci sulphatis.

℞	Zinci sulphatis	gr. 1 ad gr. 4
	Aq. destillat.	fl. oz. 1
	Misce.	

Useful in angular conjunctivitis.

Guttæ "fluorescin"

℞	"Fluorescin"	gr. 8
	Sod. bicarb.	gr. 12
	Aq. destillat.	fl. oz. 1
	Misce. filter.	

For staining erosions of epithelium of the cornea.

Guttæ "protargol."

℞	"Protargol"	gr. 40 ad gr. 100 (10 to 20 %)
	Aq. destillat.	fl. oz. 1
	Misce.	

Useful alternative solution to silver nitrate.

Injectio pilocarpinæ nitratis.

℞	Pilocarp. nit.	5 parts
	Aq. destillat	100 parts
	Misce.	

Dose 2 to 5 minims.

Liquors

Liquor argenti nitratis.

℞	Argenti nit.	gr. 5 ad gr. 20
	Aq. destillat.	fl. oz. 1
	Misce.	

To be applied with a wool mop to inner surface of inflamed lids.

Lotions

Lotio acidi borici.

℞	Acidi borici	gr. 4 ad gr. 8
	Aq. destillat.	fl. oz. 1
	Misce.	

Lotio hydrarg. perchloridi.

℞	Hydrarg. perchloridi	gr. $\frac{1}{8}$
	Aq. destillat.	fl. oz. 1
	Misce.	

Useful in purulent conjunctivitis and trachoma. May often be used with advantage in rather weaker solutions.

Lotio sodii bicarbonatis.

℞	Sod. bicarb.	gr. 15
	Aq. destillat.	fl. oz. 1

Misce.

Useful in ciliary blepharitis.

Lotio zinci sulphatis.

℞	Zinci sulphatis	gr. 1 ad gr 2
	Aq. destillat.	fl. oz. 1

Misce.

Unguenta

Unguentum acidi borici.

℞	Acid. borici	gr. 60
	Vaselin alb.	oz. 1

Misce.

Unguentum atropinæ.

℞	Atropinæ (alkaloid)	gr. 4
	Vaselin alb.	oz. 1

Misce.

Unguentum hydrargyri ammoniati.

℞	Hydrarg. ammon.	gr. 8
	Vaselin alb.	oz. 1

Misce.

Useful in sores on the lids.

Unguentum hydrargyri nitratis diluti.

℞	Unguent. hydrarg. nitratis	gr. 60
	Vaselin alb.	oz. 1

Misce.

Useful in ciliary blepharitis.

Unguentum hydrargyri oxidi flavi.

℞	Hydrarg. oxid. flav.	gr. 2 ad gr. 8
	Vaselin alb.	oz. 1

Misce.

Unguentum hydrargyri oxidi flavi cum atropinâ.

℞	Hydrarg. oxid. flav.	gr. 4
	Atropinæ (alkaloid).	gr. 2
	Vaselin alb.	oz. 1

Misce.

Unguentum iodoformi.

℞	Iodoform. præcipitat.	gr. 15 ad gr. 30
	Vaselin alb.	oz. 1

Misce.

Useful in sloughing ulcers of the cornea.

Unguentum iodoformi cum atropina.

℞	Iodoform. præcipitat.	gr. 20
	Atropinæ (alkaloid) .	gr. 2
	Vaselin alb.	oz. 1

Misce.

VISION REQUIRED FOR THE PUBLIC SERVICES

Test types used—Snellen's for distance, and Army type. The test is made in good daylight.

The Royal Navy

Full normal vision in both eyes without glasses is required for engineers and marines. In the other branches of the Navy small errors of refraction will be considered on their merits. Full colour vision must be present.

Merchant Service. Pilot Service.—The candidate must have—

1. $\frac{6}{6}$ in both eyes without glasses and must be able to read near type.

2. No squint is allowed.

3. Full colour vision must be present.

Masters, Mates, etc.—Full and normal colour vision must be present. Candidates are advised to study the conditions.

ARMY (Commission)

The candidate is considered fit if he sees—

1. $V\frac{6}{6}$ in either eye without a glass and ·6 at any distance.

2. $V\frac{6}{24}$ in either eye without a glass and $\frac{6}{6}$ with a glass in one eye and $\frac{6}{12}$ or more in the other eye, and can also read ·8 with each eye without glasses.

3. $V\frac{6}{6}$ in one eye and $\frac{6}{36}$ in the other which can be improved to $\frac{6}{12}$ with glasses.

He is considered unfit—

1. If he has less than $\frac{6}{24}$ in each eye without glasses.

2. If there is any squint or recurrent morbid condition of the eyes.

3. He must be able to recognize the primary colours.

INDIAN SERVICES

Indian Civil.—The candidate will be considered fit—

1. If he has $\frac{6}{9}$ in one eye and $\frac{6}{6}$ in the other without a glass.

2. If he has myopia not exceeding —2·5 D.

3. If one eye is $\frac{6}{12}$ with a nebula and the other eye $\frac{6}{6}$ with glasses.

He will be considered unfit if there is eye disease present or paralysis of the ocular muscles. Concomitant squint with good vision in both eyes even if binocular vision is not present, will allow the candidate to pass.

Indian Medical Police.—The candidate is considered fit—

1. If he has $\frac{6}{6}$ in both eyes and ·6 at any distance.

2. If he has $\frac{6}{24}$ which with correction will give $\frac{6}{6}$ in one eye and $\frac{6}{12}$ in the other provided he gets ·8 without a glass.

He is considered unfit if he does not obtain $\frac{6}{24}$ without glasses. The presence of squint and the inability to recognize colours also exclude.

Indian Marine, Engineers, Firemen, Pilot Service and Railwaymen.—The candidates must have $\frac{6}{16}$ in either eye and be emmetropic, have perfect colour vision, and no squint.

In the case of marine engineers and firemen a refraction error of 1 D + or – is allowed.

Forest, Survey, Telegraph, Factories, Artificers.—The candidate will be considered fit when he has—

1 Under – 2·5 D of myopia giving $V\frac{6}{9}$ in one eye and $\frac{6}{6}$ in the other provided the accommodation is normal.

2. Myopic astigmatism not more than 2·5 in the highest meridian, giving $\frac{6}{9}$ and $\frac{6}{6}$.

3. Total hypermetropic under + 4 D giving $\frac{6}{9}$ and $\frac{6}{6}$.

4. Hypermetropic astigmatism under 4 D in the highest meridian giving $\frac{6}{9}$ and $\frac{6}{6}$.

5. Corneal nebula giving $\frac{6}{12}$ in one eye and $\frac{6}{6}$ in the other.

6. Candidate must be able to recognize primary colours.

Any ocular paralysis disqualifies.

PUBLIC WORKS

In Public Works the same vision must be obtained as for the Forests with the exception that – 3·5 D of myopia or myopic astigmatism is allowed.

INDEX

Ablepharia, 291
Accommodation, 35
Acquired colour blindness, 24
Acquired syphilis, 143
Acute glaucoma, 266
Acute iritis, 170
Advancement, 351
Affections of the eyelashes, 294
Albinism, 181
Albinos, 15
Albuminuria, 25
Albuminuric retinitis, 219
Alexia, 253
Amblyopia, 251, 252
  congenital, 251
  ex anopsia, 252
Amaurosis, 251, 252
Anæsthesia, 265, 324, 328
Angle "gamma," 273
Ankyloblepharon, 291
Aniridia, 270
Anisometropia, 56
Anophthalmos, 314
Anterior polar cataract, 135, 200
Anterior staphyloma, 136
Antitoxin in diphtheritic conjunctivitis, 90
Apparent squint, 280
Arlt's operation for trichiasis, 357
Arcus senilis, 145
Astigmatism, 34, 51
Atropine poisoning, 162

Bacillus lacunatus, 75
Basal paralyses, 285
Binocular vision, 276
Blepharitis, 77, 293
Blepharophimosis, 291
Blind spot, 22
Blood supply of the conjunctiva, 67
Bowman's membrane, 146
Bulbar conjunctiva, 66
Buphthalmos, 271
Burns of the conjunctiva, 74

Calmette's ophthalmo-tuberculin reaction, 373
Canaliculi, 305
  obliteration of the, 365
  slitting the, 359
Canthoplasty, 363
Canthorraphy, 362
Canthotomy, 363
Cataract, 173, 195
  anterior polar, 197
  complete congenital, 197
  hereditary dot, 198

Cataract, lamellar, 197
  nuclear, 197
  posterior polar, 197
Cataract operation, 330
Catarrhal ophthalmia, 76
Caterpillar's hairs in the conjunctiva, 72
Cavernous sinus thrombosis, 219
Central scotoma, 247, 250
Central vision, 18
Cerebral paralysis, 287
Chalazion, 297
Changes produced by inflammation in the conjunctiva, 68
Chiasma, 236
Choroid, 156, 159, 181
  inflammation of the, 182
  tumours of the, 189
Chronic glaucoma, 269
Chronic iritis, 171
Chronic pyæmia, 176
Ciliary injection, 170, 178
Ciliary blepharitis, 294
Ciliary body, 156, 158
Circle of Zinn, 215
Coloboma of the macula, 181
  of the nerve sheath, 241
Colour blindness, 23
Colour vision, 23
Commotio retinæ, 211
Concave mirror, 31
Concomitant squint, 275
Congenital blindness, 242
Congenital night blindness, 211
Congenital ptosis, 291
Conical cornea, 144, 206, 343
Conjunctiva, 65
  burns of the, 74
  inflammation of the, 74
  operations on the, 364
  syphilis of the, 111
  tubercle of the, 109
  tumours of the, 121
  wounds of the, 72
Conjunctivitis, 77
  chronic, 92
  diphtheritic, 89
  diplobacillary, 75, 79
  follicular, 71, 100
  gonorrhœal, 80
  Koch-Week's, 78
  Parinaud's, 106
  pneumococcal, 91
  purulent, 92
  staphylococcal, 91
  streptococcal, 91
Cornea, 126
  anæsthesia of, in glaucoma, 265
  degeneration of the, 144
  foreign bodies in the, 129
  inflammation of the, 131
  tumours of the, 146
  wounds of the, 129
Cryptophthalmos, 291
Cupping of the disc, 262
Cyclops, 314
Cysts of Moll's glands, 299
Cysts of the conjunctiva, 121

Dacryo-adenitis, 303

Dacryo-cystitis, 304, 312
Daltonism, 23
Deaf mutism, 224
Descemet's membrane, 127
Degeneration of the cornea, 144
Detachment of the retina, 173, 227, 233
Diabetic retinitis, 223
Diseases of the eyelids and lachrymal apparatus, 290
Disorders of the extra-ocular muscles and movements of the eye, 272
Displacement of the lens, 204
Disseminated choroiditis, 186
Disseminated sclerosis, 248
Distance vision, 58
Distichiasis, 291
Dyslexia, 253

Eclipse Blindness, 212
Ectropion, 94, 291, 301
  of the iris, 265
  operations for, 358
Electrolysis, 356
Elementary optics and refraction, 27
  definitions, 27
  focus, 28
  pencil of rays, 27
  rays, 27
  reflection, 27
  refraction, 27
Emmetropia, 32
Enophthalmos, 316
Entropion, 100, 291, 300
  operations for, 356
Enucleation, 344
Epicanthus, 290
Epiphora, 306
Erythropsia, 253
Esophoria, 278
Evisceration, 346
Examination, 1
  by focal illumination, 3
  external, 2
  routine, importance of, 1
  subjective and objective, 2
Exophoria, 278
External rectus, 272
Extra-ocular operations, 344
Extra-ocular paralysis, 283
Extraction of the lens, 329
Eyelashes, affections of the, 294
Eyelids, 165
  œdema of the, 293
  tumours of the, 297

Field of vision, 18
Foreign bodies in the conjunctival sac, 72
Fovea centralis, 208
Frost's operation, 347
Fusion sense, 276

General examination of the patient, 25
  albuminuria, 25
  embolism, 26
  exophthalmic goître, 26

General Examination of the patient—
  heart disease, 26
  metastatic disease, 26
  myxœdema, 26
  nervous system, examination of, 25
  new growths, 26
  optic atrophy, 25
  optic neuritis, 25
  pulsation of the retinal arteries, 26
  pyæmia, 26
  thyroid disease, 26
  tubercle, 26
  urine, examination of, in cases of cataract, 25
Glasses, measuring for, 64
Glaucoma, 258
  acute, 268
  primary, 265
  secondary, 270
  operations for, 338
Glaucomatous cup, 263
Glioma of the retina, 229
Globe, punctured wounds of, 148
Gonorrhœal ophthalmia, 88
Graddy's forceps, 102

Hemiplegia, 287
Herpes Zoster, 139
Hess' operation, 353
Holes, in the retina, 211, 226, 229
  in the optic disc, 242
Holmgren's wools to test patients' colour vision, 24
Hordeolum, 295
Horner's muscle, 306
Hypermetropia, 33, 40, 260
Hyperphoria, 278
Hypopyon, 177
Hysteria, 249

Image, 30
  real, 30
  virtual, 30
Images produced by mirrors, 31
Internal rectus, 272
Interstitial keratitis, 141
Intra-ocular operations, 322
  local preparation of the patient, 322
  general preparation, 327
Iridectomy, 331
Irido-cyclitis, 141, 168
Irido-dialysis, 167
Iridotomy, 337
Iris, 156
  aniridia, 166
  bombé, 173
  congenital abnormalities of, 165
  polycoria, 165
  tubercle of the, 143
  tumours of the, 180
Iritis, 168
  acute, 170
  plastic, 168
  serous, 169
  and glaucoma, differential diagnosis, 267

Jequirity, 104
Jequirol, 105

Keratitis, 131, 138
Keratitis punctata, 140, 141, 171, 188, 267
Keratocele, 136
Kerato-malacia, 132, 134
Klebs-Loeffler bacillus, 84, 89
Koch-Week's bacillus, 89, 115
Krönlein's operation, 370

Lachrymal abscess, 312
Lachrymal apparatus, operations on, 365
Lachrymal canals, 305
Lachrymal fistula, 313
Lachrymal gland, 303
  excision of the, 367
  tumours of the, 305
Lachrymal obstruction, 307
Lachrymal sac, 306
  excision of the, 365
Lachrymation, 306
Lagophthalmos, 291
Lantern test for colour vision, 24
Lens, 193
Lenses, 28, 63
  numbering of, 29
Lenticonus, 144, 206
Leucoma, 135, 136
Levator palpebrae, 355
Limbus, 66
Loss of vision in glaucoma, 264
Lupus, 296
Lymph passages of the eye, 161
Lymphangectiasis, 121
Lymphoid follicles, 70

Macula lutea, 18
Maddox rod, 62, 277
Malingering, 249, 252
Meibomian glands, 66
Microphthalmos, 314
Migraine, 251
Miliary tubercle, 186
Mooren's ulcer, 139
Morax-Axenfeld bacillus, 74, 75, 84, 91
Mule's operation, 346
Muscular balance, 277
Mydriasis, 162
Mydriatics, 60
Myopia, 33, 44, 261
  operative measures for, 50

Naevi, 299, 319
Nebula, 136
Needling, 335
Neuritic atrophy, 254
Neuro-fibromatosis, 299
Neuro-paralytic ulcer, 134
Nitrate of silver, 85, 86, 89
Normal fundus, 15
Nuclear paralyses, 286
Nystagmus, 288

Oblique muscles, 272
Observer's fields for taking peripheral vision, 23

Ocular paralysis, 288
Onyx (abscess of the cornea), 134
Opacities of the cornea, 146
Opaque nerve fibres, 210
Operations on the extraocular muscles, 347
Ophthalmia neonatorum, 80
  percentage of in England, 81
  prevention of, 85
Ophthalmia nodosa, 72
Ophthalmic migraine, 288
Ophthalmic operations, 322
Ophthalmometer, 53
Ophthalmoplegia, 286
Ophthalmoscope, 53, 144
Ophthalmoscopic examination, 5
  indirect and *direct*, 6
  indirect method, advantages of, 8, 9
  cupping of the disc, 10
  fundus, examination of all parts of the, 10
  macula, 10
  magnification of the fundus, 11
  optic disc, 10
  parallax, 10
  direct method, advantages of, 12
  estimation of refraction, 13
  examination of opacities in the media, 14
Ophthalmoscopic judgment of the size of foci of disease in the fundus, 14
  measurement of depressions and elevations, 14
Optic amnesia, 252
Optic atrophy, 253
Optic disc, 16
Optic nerve, 235
  diseases of the, 235
  tumours of the, 256
Optic neuritis, 243
Optic tract, 238
Optical centre, 30
Optical iridectomy, 342
Orbit, 314
  fractures of the, 316
  operations on the, 369
  tumours of the, 319
Orbital cellulitis, 318
Orthophoria, 278
Oxycephaly, 315

Panas' operation, 354
Pannus, 99, 105
Panophthalmitis, 135, 177
Parallel rays, 30
Paralyses, 285
  basal, 287
  cerebral, 287
  conjugate, 287
  nuclear, 286
  ocular, 288
  pontine, 286
Paralytic strabismus, 282
Pediculi pubis, 295

Pemphigus, 117
Perimeter, 20, 280
Peripheral contraction of the field of vision, 23
Peripheral parts of the retina, examination of, 18
Peripheral vision, 20
Peritomy, 364
Phagocytosis, 103
Phlyctenula, 94, 112
Phlyctenular ulcers, 133
Pinguecula, 117
Placido keratoscope, 144
Plane mirror, 31
Posterior polar cataract, 200
Posterior synechiæ, 172
Presbyopia, 36, 43
Prescriptions, 373
Principal axis of a lens, 30
Primary ray, 30
Proptosis, 315
Pseudo-glioma, 177
Pterygium, 117, 364
Ptosis, operations for, 352
Pulsating exophthalmos, 317
Pulsation of the retinal artery, 263
Punctum proximum, 36
Punctum remotum, 36

Reaction of the pupil to drugs, 162
Reflex stimulation, 161
Refraction, 31
Retina, 208
  congenital abnormalities of the, 210
Retina, detachment of the, 173, 227, 233
  diseases of the, depending on vascular degenerations, 212
  glioma of the, 229
  inflammation of the, 226
Retinal degeneration associated with cerebral degeneration, 225
Retinal detachment, 190, 205
Retinal image, 34
Retinitic atrophy, 255
Retinitis, 226
  albuminuric, 219
  pigmentosa, 224
Retinoscopy, 53, 37
Retrobulbar neuritis, 246
Rodent ulcer, 300
Ruptured choroid, 182

Sclerotic, 146
  ectasia of the, 153
Scleral puncture, 342
Scleritis, 151
Sclerotomy, 341
Scotoma, central, 247, 250
  measurement of, 35
  scintillating, 251
Scotomata, 22
Scotometer for testing central vision, 18
Septic choroiditis, 187
Serpigenous ulcer, 134, 311
Shadow test, 37

Silver nitrate, 104
Snellen's sutures, 359
Spectroscopic test for colour vision, 24
Spring catarrh, 106
Squint, 274
  apparent, 280
  latent, 277
Steamy cornea, 265
Stelwag's brawny œdema, 98
Strabismus, 274
Striate keratitis, 144
Stye, 295
Sub-conjunctival hæmorrhage, 73
Subhyaloid hæmorrhage, 222
Sulcus subtarsalis, 66, 72
Sun-blindness, 212
Symblepharon, 74, 118, 291, 303, 364
Sympathetic irido-cyclitis, 178
Syphilis, 185
  acquired, 143
  of the conjunctiva, 111
Syphilitic retinitis, 226

Tarsitis, 294
Tarsorraphy, 363
Tay's choroiditis, 214
Tenotomy, 281, 349
Tension, 3, 4, 5
Test types, Snellen's, 56
  Jaeger's, 58
Thrombosis and embolism of the central artery of the retina, 215
Tower skull, 315
Toxic amblyopia, 248, 250
Trachoma, 95
  follicular, 97
  papillary, 97
Trichiasis, 100, 291, 296
  operations for, 356
Tubercle of the conjunctiva, 109
Tubercular choroiditis, 186
Uveal tract, 156, 180

Vaccinia, 111
Vascular sclerosis, 216, 250, 262
  of the choroid, 189
  of the ocular vessels, 214
Vision for distance and near, 5
  required for the public services, 378
Visual acuity for testing central vision, 18
Visual aphasia, 253
Vitreous, 208
  diseases of the, 232
Vitreous hæmorrhage, 234
"VY" operation, 361

Xerosis, 119, 133
Xerosis bacillus, 90
X-rays in trachoma, 105
  in foreign bodies in the eye, 149

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